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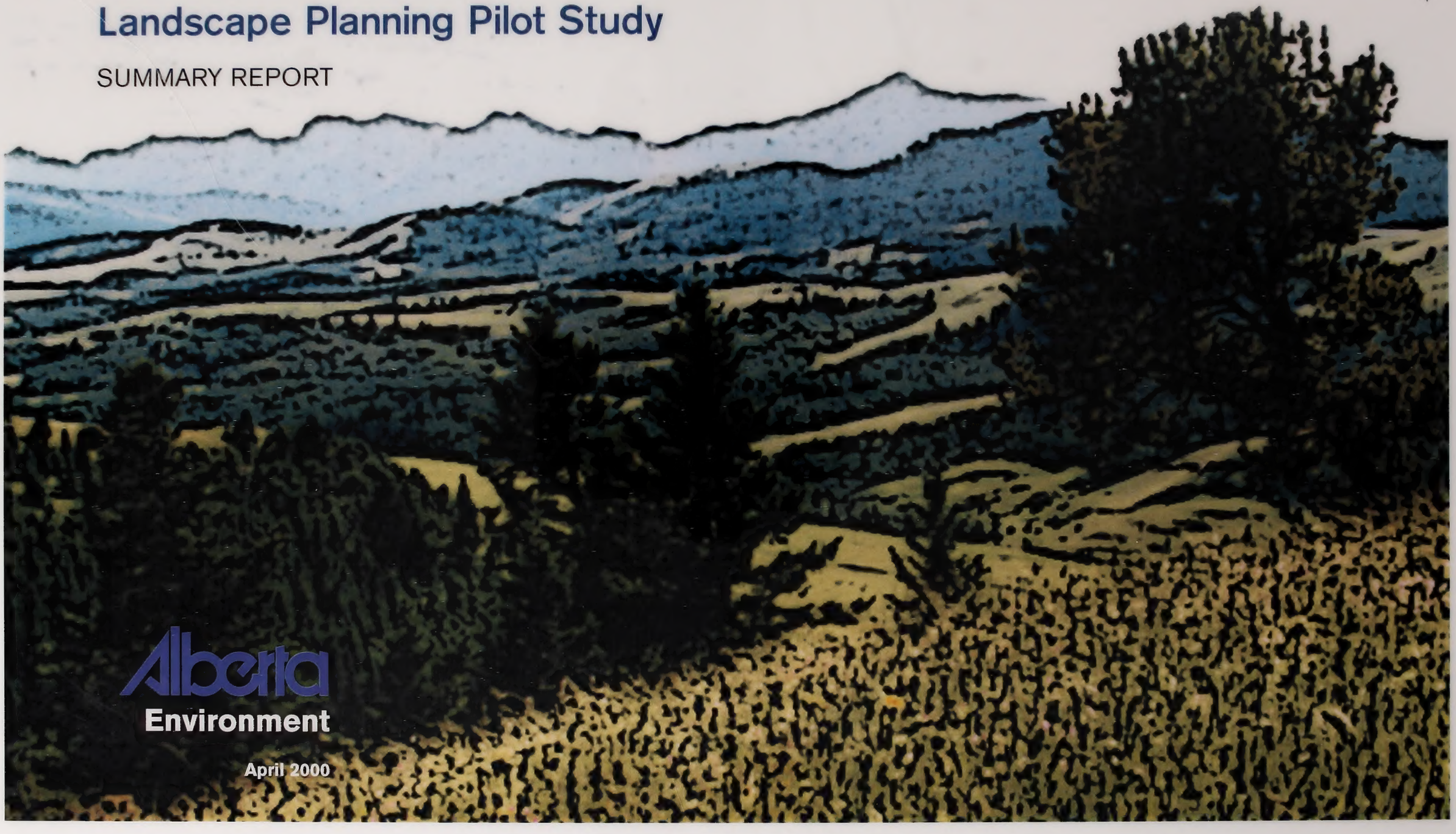
The Southern Rockies Landscape Planning Pilot Study

SUMMARY REPORT



Alberta
Environment

April 2000

NOTE:
Every effort has been made to ensure the accuracy of the information in this report. Any opinions expressed are those of the authors and do not necessarily reflect the position of Alberta Environment.

The Southern Rockies Landscape Planning Pilot Study

SUMMARY REPORT

Alberta

Environment
Land and Forest Service
Integrated Resource Management Division

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1. Introduction

This summary report of the Southern Rockies Landscape Planning Pilot Study outlines the approach and methods used to develop and test a set of regional planning tools and models. The work has been applied to research aimed at providing support and direction to future integrated resource management and planning in the province.

The report provides a summary of major findings and does not detail the methods used. Readers are referred to the following project reports which are available from Alberta Environment for greater detail:

Disturbance and Pattern Analysis
Silvicultural Typology
Watershed Report
Visual Resource Report

1.1. THE NEED FOR REGIONAL LANDSCAPE PLANNING

Planning systems for public land and resources face multiple and complex challenges. Increasing and often conflicting demands on the resource base as well as a need to understand and respond to natural processes has made planning more complicated. The need for forest management in Alberta that is consistent with both the maintenance of the Province's natural heritage and the provision of societal benefits for generations to come has been identified (Alberta Forest Legacy, 1998). In response to these demands, a comprehensive, pragmatic and adaptive approach to forest landscape planning and management is required.

The current approach to forest management in Alberta is outlined in the 1998 Alberta Forest Legacy document developed by the provincial government. Among others, the document provides direction in the following areas:

- "The Alberta Forest Legacy sets out a management approach that reflects citizens' desires to maintain, on provincially–owned land, their access to the diverse economic, cultural and recreational benefits that are provided by, and are dependent on sustainable forest ecosystems."
- "The Alberta Forest Legacy calls for activities in the forest to be managed in such a way as to allow the forest landscape to continue to evolve under the influence of disturbances that are, in scale at least, similar to those disturbances that shaped them in the past."
- "More collaborative forms of forest management planning will evolve between the various industrial, commercial and community users of the forest whose areas of interest overlap. These planning approaches will utilize full landscape planning and integration of the full range of management intensities – heritage, extensive, facility and enhanced. Public involvement is a legislated requirement."

The Interim Forest Management Planning Manual developed by Alberta Environment also provides guidance on how forest landscape planning should proceed. Some excerpts are:

- Planning needs to... "address the biological, economic and social aspects of the area."
- Plans are needed "that will utilize a landscape assessment approach to resource management and decision–making."
- There is a need to define "The desired future forest state...on the basis of the results of a landscape assessment."

Resource planning must be able to predict and evaluate the cumulative ecological and socio–economic effects of management over broad areas of space and long periods of time. In addition, a clear vision of alternative forest futures is necessary, so that decision–makers and the public can understand the opportunities, limitations, trade–offs and impacts of potential management scenarios. New tools, such as geographic information systems (GIS), remote sensing, computerized landscape visualization and regional landscape analytical techniques provide opportunities to meet these challenges. The new techniques allow for the presentation of complex data in a highly visual manner and help to ensure meaningful stakeholder and public consultation. These tools also allow planners to consider the impacts of various alternatives within a nested hierarchy of scales ranging from the forest stand to the broader landscape and region.

Although many definitions exist, the concept of landscape as "a mosaic where a cluster of local ecosystems is repeated in similar form over a kilometers wide area." (Forman, 1995), has been used throughout the study. Although there are no formal size limits, landscapes generally range from at least a few kilometers in diameter to several hundred kilometers in extent.

While many factors, other than purely ecological, influence forest management plans, the ecology of the landscape must be fully considered if desired future conditions are to be sustainably obtained. Landscape ecology concentrates on the structure and pattern of the landscape, its function in terms of flows of energy, materials and organisms between elements, and the change occurring within the heterogeneous landscape mosaic over time (Forman and Godron, 1986). It is distinguished from ecology by its emphasis on spatial pattern, heterogeneity (Turner et al, 1991), and by the specific inclusion of human activities.

Landscape ecological investigations such as pattern and structure analysis, disturbance studies, identification of critical thresholds and studies of landscape change over time are directly applicable to regional landscape planning. Understanding the changes, flows and spatial relationships of species, energy and nutrients across the landscape, including the ability to resist and recover from disturbances such as fire, is of great importance to planning.

There is increasing recognition "that all ecological processes occur within a spatial context" (Turner et al, 1991) and that there are important correlations between spatial patterns and landscape processes. Structural characteristics may be correlated to such variables as fire dynamics, suitability of habitat for wildlife, water quality and quantity, biodiversity, as well as the productivity and availability of renewable resources. Landscape structure is used here as:

"the spatial relationships among the distinctive ecosystems or "elements" present – more specifically, the distribution of energy, materials and species in relation to the sizes, shapes, numbers, kinds and configurations of the ecosystems" (Forman and Godron, 1986).

Understanding the processes that give rise to landscape patterns over space and time should inform human interventions. The dynamic nature of the shifting landscape mosaic must also be considered. Processes such as disturbance regimes, physiographic influences, successional trajectories and wildlife habitat requirements etc., operating at varying spatial and temporal scales, need to be understood and incorporated into the decision–making process.

Much research indicates that sustainability is probably best achieved at the regional level (Forman, 1995) and that more emphasis should be placed on regional scale analysis and characterization (Hann et al, 1994). It is the landscape and regional scales that offer the most promise to achieve a sustained flow of benefits from a shifting mosaic. While there will undoubtedly be rapid shifts in the condition of individual elements, the region as a whole may exhibit slow change in its foundation variables (i.e., biomass, regional biodiversity, wildlife populations, quality and quantity of water, etc.).

This pilot study has provided an opportunity to craft planning methods that are suited to Alberta's unique ecological and social environment. Spatially explicit planning tools, which identify the cumulative broad scale impacts of various planning alternatives, have not been developed in the province and are critically needed. This study addresses that need and demonstrates the application of new methods and their potential future role in planning for sustainable environments.

1.2. PROJECT INTENT AND OBJECTIVES

The Southern Rockies Landscape Planning Pilot Study was initiated in 1996, in response to a changing provincial land management paradigm. The project is a multi–disciplinary pilot study to develop planning support tools that may be used to evaluate the impacts of alternative future landscape scenarios over time. The intent of the project is to examine the connections between land use activities and the consequent impacts on the ecological, visual/cultural and economic resources of the study area. The project has identified a range of alternative futures for the area and their associated potential impacts.

The overriding objective has been to provide a suite of methods and tools that may be used to support future planning in the area and that will provide a prototypical example for other landscape planning projects in the province. A set of simulation models was assembled that may be used by regional and local planners to model the potential impacts of planning scenarios as they change and evolve over time. The suite of analysis, simulation and design tools that have been developed are the main products of the project. As new proposals for landscape change are developed, they can be evaluated with these tools and the cumulative effects of multiple interventions considered.

The objectives of the study are:

- Develop and test a framework for the organization and application of models which support integrated planning for the allocation and use of public natural resources.

- Contribute to the conservation of the ecological, cultural and economic resources of the area by providing a framework for integrating current research and planning efforts in the region.

- Identify existing or develop new models for a part of the southern east slopes of the Rocky Mountains that project alternative potential scenarios into the future and that identify the associated impacts of those alternatives over time. The models have the following characteristics:

  - based upon the principles of landscape ecology and sustainable ecosystem management.

  - simulation models that predict and evaluate the cumulative effects of various landscape scenarios over space and time. Those effects are related to biodiversity, wildlife, water, fire risk, timber, grazing, recreation, visual quality and the regional economy as well as other resources and values.

  - they are primarily spatial models, with an emphasis on regional landscape patterns and scales.

- Develop models for the study area that are relevant to future planning of that region and that may (with some modification) be applied elsewhere in the province.

- Assemble a digital geographic information system (GIS) database to support landscape planning in the region.

- Provide interdisciplinary learning and technology transfer opportunities for Alberta Environment staff and the forest industry.

- Support a transition from sustained yield forest management (fibre emphasis) to sustainable forest management (integrated ecological/socio–economic emphasis).

Provincial Context Map

1.3. PROJECT CONTEXT

The pilot project has focused on a portion of the C–5 forest management unit in the southwestern portion of the province. The area, which includes the former Crow Forest and Porcupine Hills, encompasses approximately 5,058 km² (505,837 ha) of forested and grassland foothills and steeply mountainous terrain. The study area includes private and Crown lands lying to the east of the continental divide and extending to the ranchlands west of Claresholm, north to Kananaskis Country and south to approximately the Westcastle area. (refer to provincial location map and LANDSAT TM maps). The area lies within 1 1/2 hours of Calgary, and public scrutiny of both the use and management of the area is increasing.

The region is one of the most biologically diverse areas in the province sitting at the intersection of several natural subregions including the montane, subalpine, foothills parkland and foothills fescue grassland subregions. It is comprised of several landscapes upon which there is a complex mix of resource demands in multiple sectors. The area has outstanding forestry, wildlife, grazing, recreation and visual resources, and contains some of the most important watersheds in the province.

Land use in the area has a long history. First Nations' use of the area dates back several thousand years and many important archaeological sites exist. Settlers moved into the area in large numbers in the late 1800s, establishing ranches and farmsteads. While the main land use activity at that time was ranching, logging in both the Porcupine Hills and the area surrounding the Crowsnest Pass has been common since the turn of the century.

The Crowsnest Pass communities that are still the only urbanized centres in the study area, were established largely as mining centres in the 1890s. Since that time, land use throughout the area has slowly intensified but still is dominated by large ranches, forestry, recreational use and a relatively minor amount of arable agriculture.

The study area contains resources of enormous provincial importance and is facing mounting pressure for both development, resource extraction, and at the same time, for conservation. It is therefore an ideal, although complex area to develop new tools for regional landscape planning. Most of the issues and potential conflicts that will have to be addressed in forest management throughout the province arise in this region. Importantly, the methodology developed will be transferable to other areas. The details will change, but the approach may be similar.

All photographs – Glenbow Archives

Ezera Left Hand and family

Mead Ranch Todd Creek

Mowing Hay in the Porkies 1914

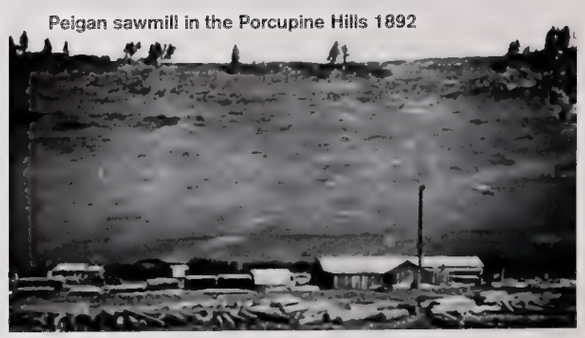
Logs on the Oldman River 1912

Near Blairmore 1925

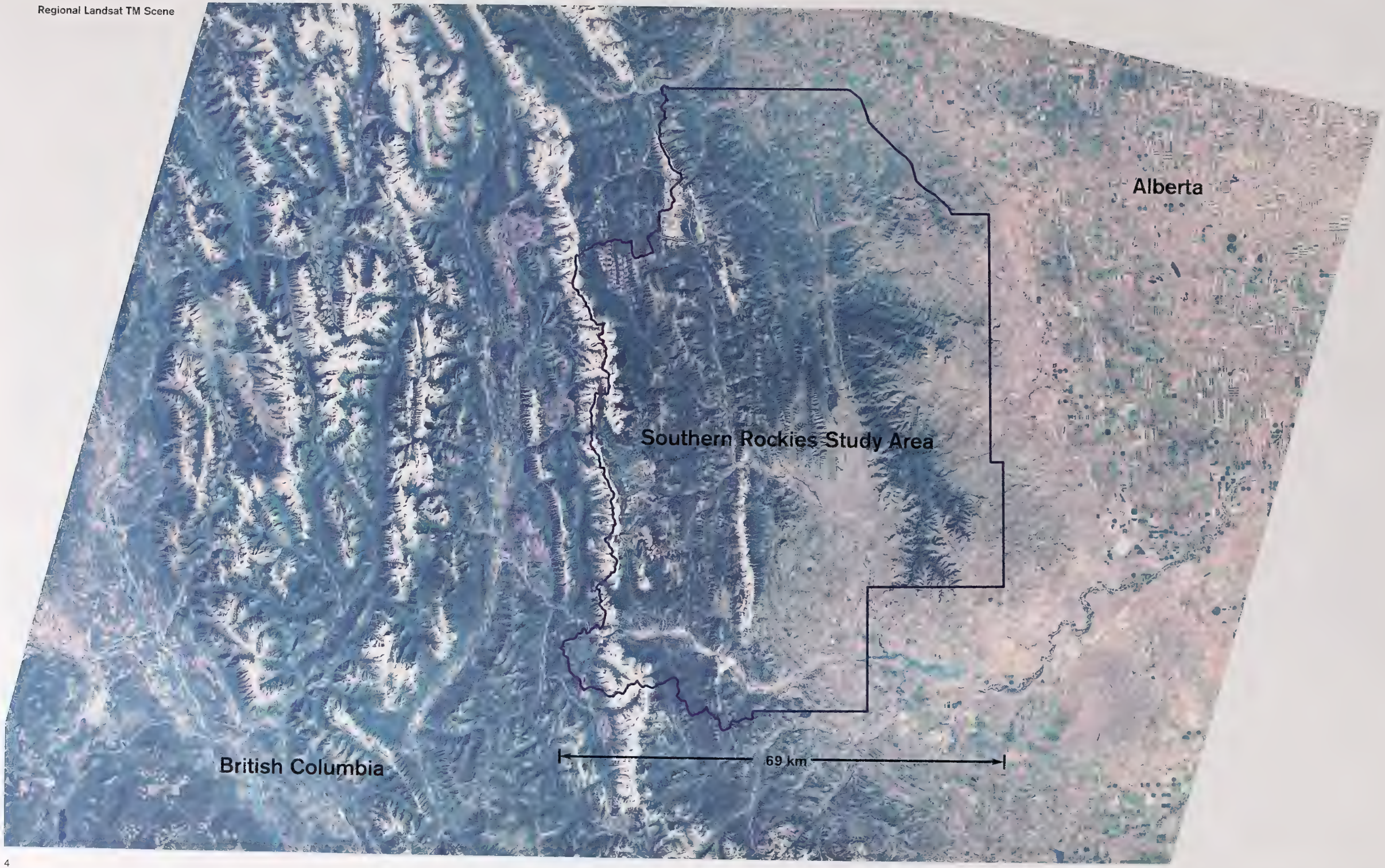
North West Mounted Police 1894

Roundup crew in Porkies 1886

Peigan sawmill in the Porcupine Hills 1892



Regional Landsat TM Scene



1.4. STUDY APPROACH

The work takes a landscape and regional view and adopts a long–term strategy by examining the history of the region as well as the processes that underlie landscape function and projecting potential scenarios into the distant future. Understanding the natural range of variability currently and historically present in the landscape has been central to the work. Most of the methods and analytical techniques used in the study have been derived from the fields of landscape planning, landscape ecology and ecosystem management.

The study has emphasized the understanding of ecological processes and the impacts that human interventions and natural disturbances have on both landscape structure and function. The delineation of analysis and operational units at all scales has been based primarily upon ecological criteria. A standardized ecological land classification of the study area and a characterization of the landscape patterns and processes within a nested hierarchy of scales has been fundamental to the study. While the study stems from a desire to maintain ecological integrity, cultural and socio–economic factors including timber and grazing supply, visual quality and others, have played an important role in the project development and inquiry.

A common spatial language has been used to describe all alternatives and is shared by all impact models including, among others, wildlife habitat and avian biodiversity, visual quality, timber and grazing supply.

1.5. PROJECT FRAMEWORK AND ORGANIZATION

Regional landscape planning studies are generally complex, multifaceted and costly. It is therefore necessary to provide a framework to both organize the various tasks and models and to aid in the identification of minimum data requirements. The framework directs all actions in support of informed decision–making, not merely answering interesting scientific questions. By organizing a range of scientific, social and economic investigations that are directly related to areas of societal concern, the framework helps to ensure that decisions are based upon clearly defined principles and measurable criteria.

The methodologies used in landscape planning must be open, modular and adaptive. Open, in the sense that evaluation criteria must be explicit and transparent to careful public examination. Modular and adaptive, in order to allow models to be updated as ecological understanding of landscapes increases and societal demands change over time.

The following framework for landscape planning, borrowing heavily from Steinitz (1990) and Steinitz et al. (1996), has been used to organize the various aspects of the work. Figures 1 and 2 represent the generalized framework and a more detailed diagram indicating the various components of the work. Project investigations fall into six general categories of models.

I. REPRESENTATION MODELS – *How should the landscape be described?*
A Geographic Information System (GIS) was used to store and retrieve data relevant to the areas of investigation. Information on physiographic, biological and cultural resources, current plans and policies, as well as historical data was assembled within the GIS.

II. PROCESS MODELS – *How does the landscape operate?*
The landscape processes that influence key decision criteria must be understood. The relationships between such components as land cover and wildlife need to be understood and be able to be modelled within the GIS environment. Process models that were assembled during the study included; potential habitat models for single species of concern, avian diversity, successional trajectories of ecosite phases over time, stream flow response to land cover change, visual preference for various landscape conditions, potential fire behaviour, grazing productivity, fibre analysis, economics and others.

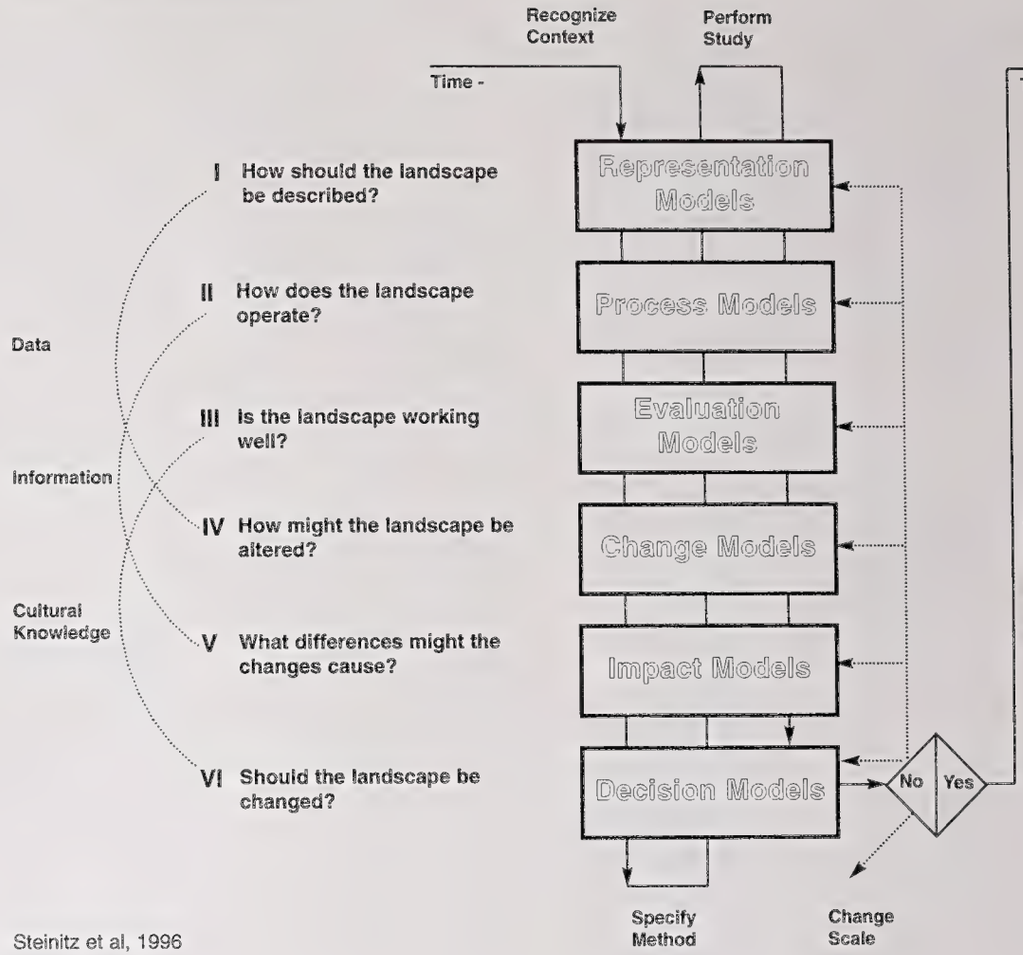
III. EVALUATION MODELS – *Is the landscape working well?*
The existing landscape needs to be evaluated in order to understand how well it is meeting cultural expectations in various sectors. The process models from the previous stage are run on the existing data. A culturally based evaluation of the model outputs gives rise to the overall assessment of the region. The set of evaluations that have been undertaken in the pilot are meant to represent the likely minimum set of analyses that decision makers need to be informed of. These are related to economic values, as in the supply of wood and grazing, to ecological values, as in the conservation of biodiversity and habitats of species of concern, as well as to other societal concerns such as the stewardship of the visual resource and the protection of important historical or archaeological resources.

IV. CHANGE MODELS – *How might the landscape be altered?*
The regional landscape is by no means static and change is a certainty. Change will be brought about either through planned human interventions or by inaction and the projection of current trends into the future. The configuration of the landscape will have a profound effect on many impact variables. Several alternatives have been put forward in order to test both the planning approach as well as the details of the various models. These alternatives include current trends as well as other scenarios with differing emphases including a protection–oriented scenario as well as others in which fibre production or recreation is emphasized. In addition, catastrophic fire events have occurred in the past and are likely to in the future. A Disturbance Scenario has therefore been put forward in which a large fire event occurs again.

V. IMPACT MODELS – *What measurable difference might the changes cause?*
The process models are run on the various alternatives and the results are compared with those from the existing conditions to yield either positive or negative impacts of change. These are the same models that are used to evaluate the existing conditions in early stages and relate to risk to wildfire, protection of valued resources, and the flow of species and products from the landscape.

VI. DECISION MODELS – *Should the landscape be changed?*
The pilot project specifically avoided the decision–making process as it relates to real planning in the area. However, while the specifics of decision–making were not addressed in the pilot, it is clear that the efforts would greatly support it.

Figure 1. Generalized Framework



Steinitz et al, 1996

The framework has been used at three stages during the project. The first was to recognize the context of the investigations, the second was to develop the methodology and specify the minimum data requirements and the third was to actually carry out the study.

STAGE ONE: RECOGNIZE CONTEXT

The first stage of the process is used to provide a reconnaissance survey of the major issues and context of the study. At this point, the direction of use of the framework is from top to bottom. The existing description and representation of the region is examined and a very general knowledge of how the landscape works is obtained. Obvious problems, known potential plans and interventions, the possible impacts of those interventions, as well as an understanding of how and upon what criteria decisions are made, are determined during this overview stage.

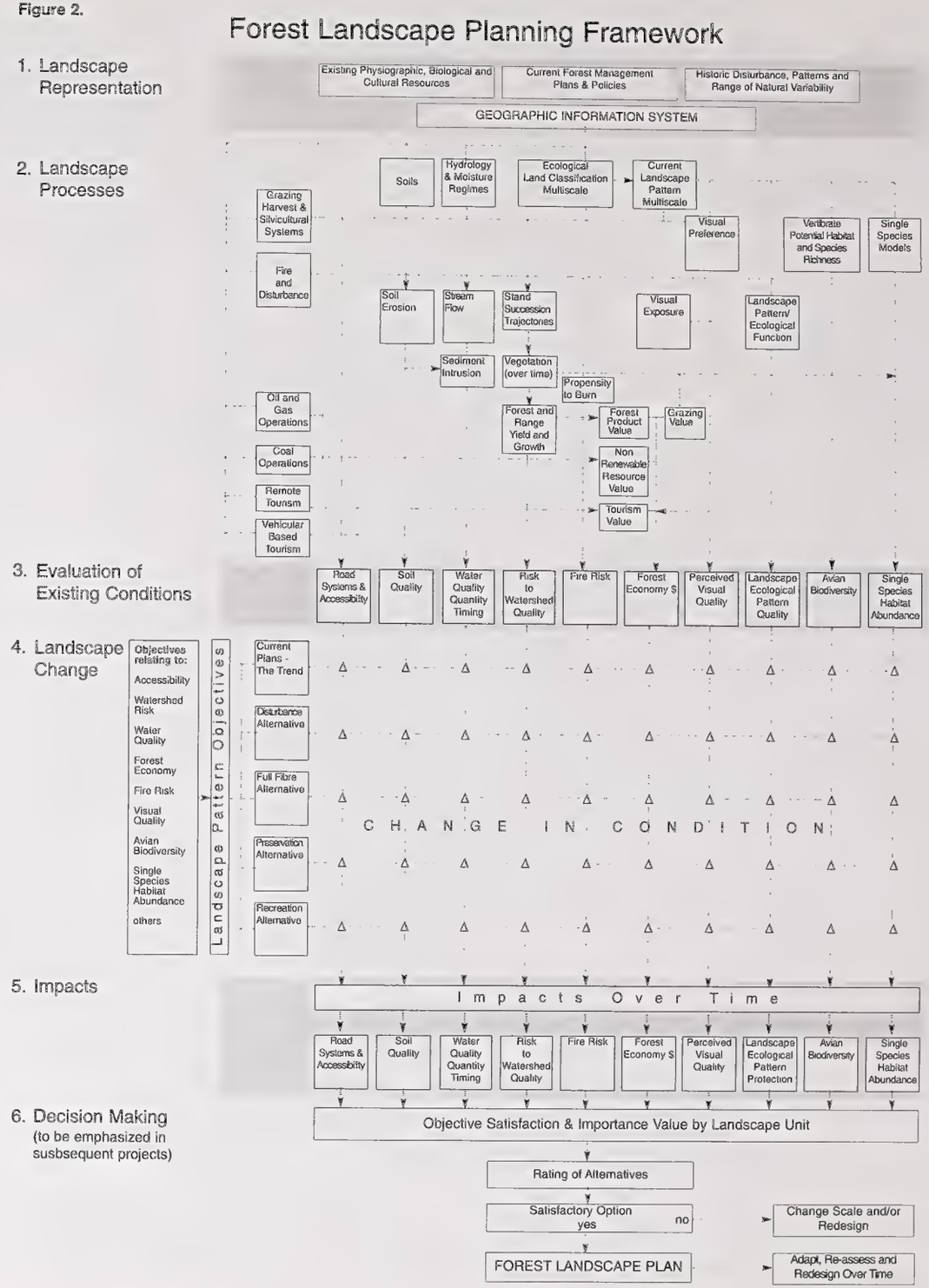
STAGE TWO: SPECIFY METHOD

In the second stage, the framework is used to fully detail the method to be employed in the study. It ensures that each stage feeds directly into the next and eliminates redundant data gathering. It also encourages the development of rational evaluation criteria. At this stage, the framework is used from the bottom up with the rationale that the place to start in developing a methodology is not to gather data. Rather, it is in understanding how decisions to change the landscape are made. Those decisions are based upon impact criteria that decision makers, and those that they represent, are interested in. The impacts (positive or negative) are caused by changes to the landscape; either projected by trends or through designed interventions. However, before changes are made, the existing landscape conditions must be evaluated. In order to understand if the region is functioning well, the structural and functional relationships that influence various landscape processes have to be known. Once those processes are understood, landscape data and minimum representational requirements can be identified (i.e., surveys, maps, plans, three–dimensional digital models, sections, reports, etc.).

STAGE THREE: PERFORM STUDY

The third stage in which the framework is used is when the project is actually carried out. Here the approach is again from the top down. The data is gathered and represented in a format that can be used in the following steps; the process models are constructed, the existing landscape is evaluated, various alternative future projections or designs are produced, the impacts of those changes are determined and a decision is made whether or not to accept the change or if a redesign or a change of scale is required.

Figure 2.



2. Landscape Representation

The following section outlines the general approach to the description of the landscape. The landscape representation has been designed to allow the greatest flexibility and to ensure that the data acquired is relevant to the required modelling. As base data acquisition is one of the most costly aspects of broad scale regional landscape planning, the identification of minimum data requirements is essential.

2.1. MINIMUM DATA REQUIREMENTS

Using the project framework to identify minimum base information requirements, the data was assembled within a computerized geographic information system. The following digital base data sets were acquired or prepared:

LandsatTM August 1996
Digital Ortho Photography (scanned from hardcopy)
Ecological Land Classification
Physical Land Classification
Soils
Inferred from Physical Land Classification
Preliminary Soil Survey Results for a Portion of the Area
Topography
Vector Contours
Digital Elevation Model at 25m raster
Slope (derived)
Aspect (derived)
Hydrography
Watershed Sub Basin Boundaries
Crown Lands
Forest Reserve Boundary
Climate (rainfall)
Alberta Vegetation Inventory
Special Places Program Sites (Current And Proposed)
Administrative Boundaries/Features
Grazing/Range Management Units
Wellsites, Pipelines Locations
Recreation Areas, Campgrounds
Archaeological Sites
Rare Plants
Ecologically Significant Areas
Protected Areas
Access
Wildlife, critical habitats, corridors, wintering areas, etc.

2.2. TECHNICAL IMPLEMENTATION

Due to both the volume of data and the need to spatially integrate many different models over large areas, a computerized Geographic Information System was required. The following sections outline the hardware and software that were used in the project and could reasonably be expected to be used in any similar work.

2.2.1. HARDWARE

The intensity of the processing required high speed computers with large amounts of memory. Several hardware platforms were used including:

- Silicon graphics High Impact R10000 Unix workstation with 400 megabytes of RAM
- 450mhz Windows NT computers with 392 megabytes of RAM
- Macintosh G3 computers with 192 megabytes of RAM

Other hardware considered essential for the project were:

- 24 gigabytes of hard disk storage space
- Writeable CD ROM for additional storage
- 8mm and 4mm Tape Drive Back up
- 11x17 colour laser printer
- Large Format HP 750C postscript plotter
- Digital projector
- Agfa Scanner

2.2.2. SOFTWARE

The following software packages were used intensively throughout the project:
Geographic Information Systems

- ERDAS Imagine 8.3 Remote Sensing and Geographic Information System was used for the majority of the raster (grid based) modelling and some vector editing.
- ThinkSpace Inc. MFWorks (Map Factory) was used for many of the raster models.
- ESRI ARCInfo was used for some vector editing and data manipulation.
- ESRI ARCView (including spatial analyst) was used for minor editing and display.

2.2.3. VISUALIZATION SOFTWARE

The need to clearly and legibly visualize data, particularly the impacts of various alternatives, is critically important to the landscape planning process. In order to provide meaningful public involvement as well as to inform decision makers and other stakeholders as to the implications of various choices, data must be displayed in a highly accessible manner. Highly visualized data is an enormous aid to the process. As the impacts of regional land use decisions are receiving increased public scrutiny, lay people must be able to understand the information presented by both government and industry. Maps over relief offer orientation that is often lacking on normal maps. Perspective views of the landscape at a number of scales are more easily understood than standard map products. All maps that have been produced in the project may be viewed and queried in perspective view and in stereo with goggles if desired. The following software was used for visualization:

- ERDAS Imagine™ Virtual GIS 8.4 was used for broad scale data visualization and data query in stereo (refer to Figures 3 and 5).
- World Construction Set 4.5 was used for finer scale visualization.
- Photoshop was used to manipulate photographic images (refer to Figure 4).
- Apple Quick time VR was used to construct panoramas suitable for electronic distribution.

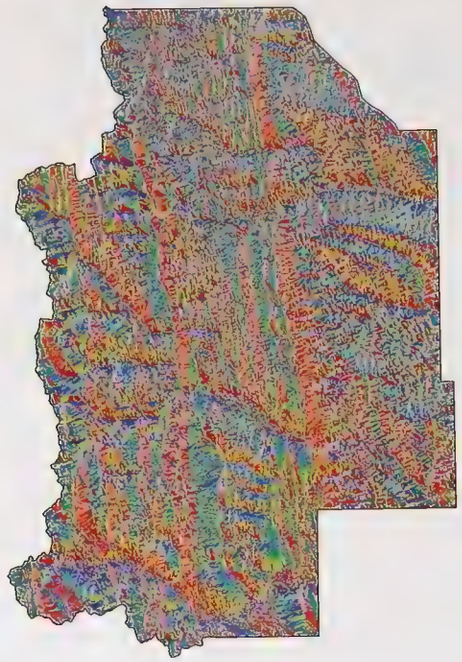
Other Software:

- Remsoft Woodstock and Stanley were used for spatial wood supply analysis.
- WRENNS was used for hydrological analysis.
- Spatial Fire Management System was used for Headfire Intensity Modelling.
- Microsoft Excel was used for the Economic Model.
- Quark Xpress and Adobe Acrobat were used for publishing. All maps were composed in ERDAS Imagine. The digital files were then either printed directly as hard copy maps or distilled into digital Adobe Acrobat pdf files for distribution electronically or inserted into desk top publishing software.

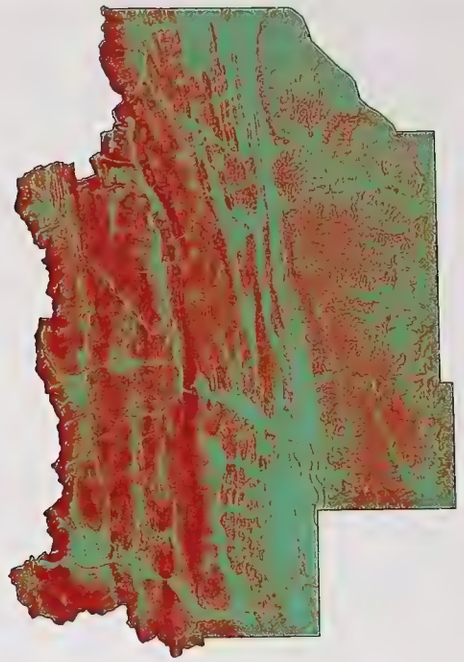
Digital Elevation Model

Scale 1:925 000

Aspect



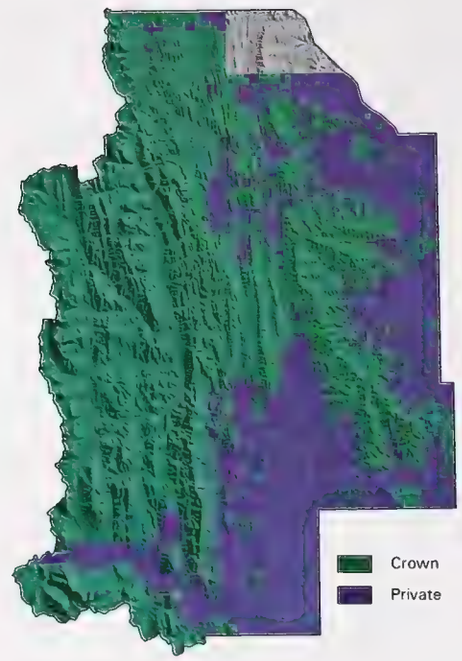
Slope Class



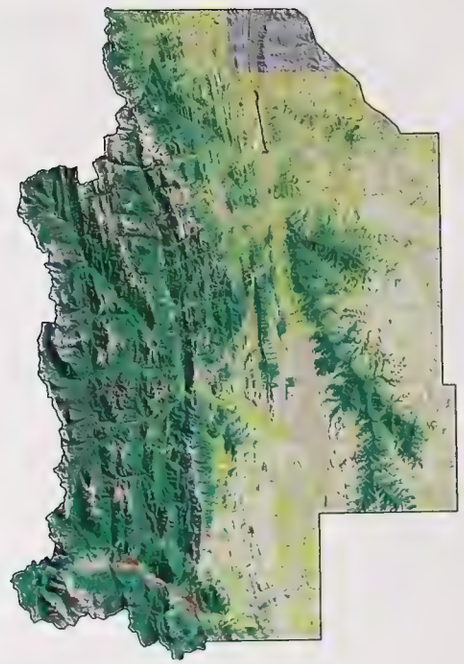
Slope Position

Hydrography

Crown and Private Lands



Forest Cover



Access

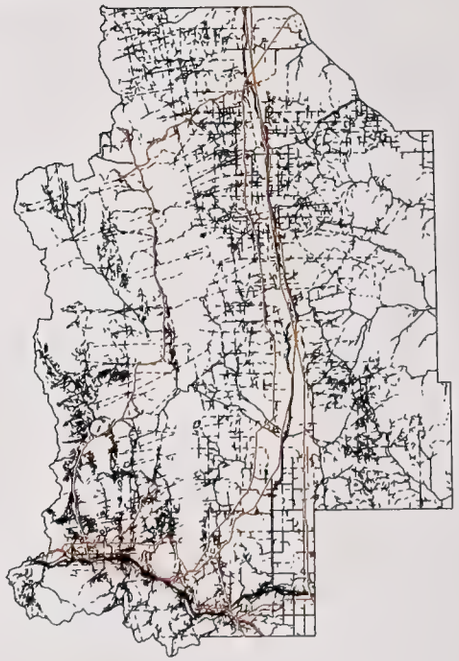


Figure 3. Perspective View of Landscape Compartments

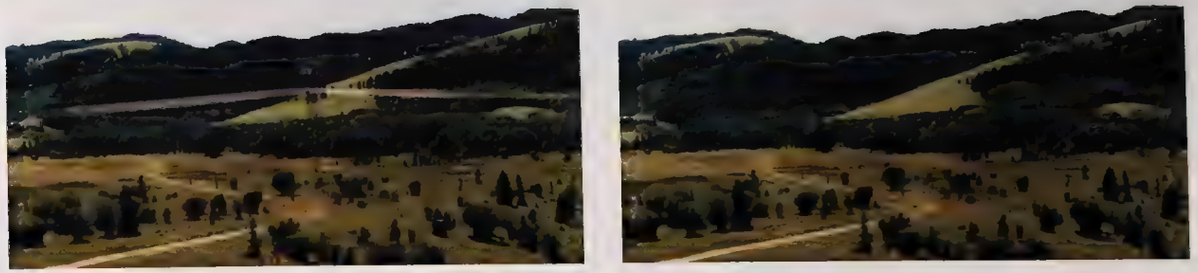


Figure 4. Photorealistic Representation of Human Interventions, before and after

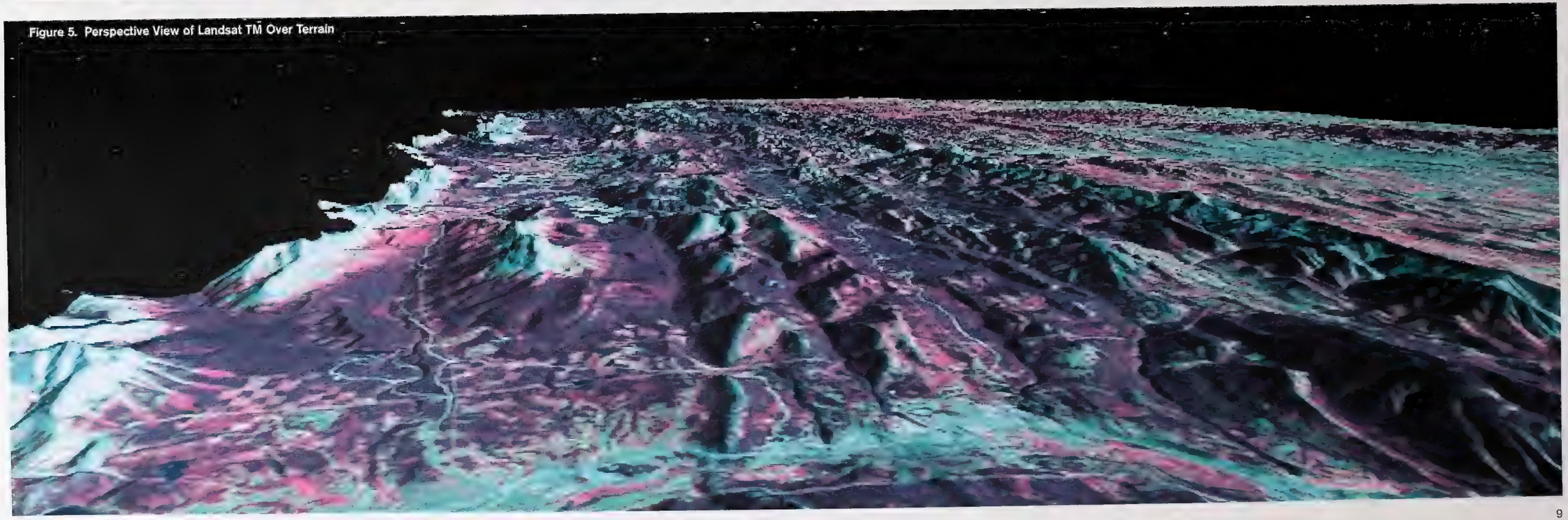


Figure 5. Perspective View of Landsat TM Over Terrain

2.3. SPATIAL HIERARCHY AND PLANNING SCALES

Different processes at different spatial and temporal scales (Turner et al, 1991) control environmental heterogeneity. The analysis of processes operating in a region as well as prescriptions for change must therefore be carried out within a spatial hierarchy. The establishment of a suitable hierarchy for both analysis and planning has been a major focus of the study.

Characterization of patterns and conditions was carried out by region, natural subregion and landscape management unit as well as, in some cases, ecosite. While natural subregions have been examined, and have proved extremely useful in the delineation of landscape management units, this scale has not been central to most of the analysis. Rather, the region and the landscape are the major focus of the work. Watersheds have also been analyzed. The hierarchy of the planning and analysis units are as follows:

Region
Landscape Management Unit
Watershed Sub Basins
Landscape Compartments
Ecosite Phase

2.3.1. REGION

A region is often considered as "a broad geographical area with a common macroclimate and sphere of human activity and interest". (Forman, 1995; Dickinson, 1970; Isard, 1975). The south eastern slopes region, which in fact is much broader than the study area itself, extends south to the United States border and north to at least Banff National Park including Kananaskis Country. For the purposes of this prototypical project, the study area, which is subregional in scale, is considered as the region. It includes those lands lying to the east of the continental divide and extending to the ranchlands west of Claresholm north to Kananaskis Country and south to approximately the Westcastle area (refer to location map). The study area includes the northern portion of the C5 forest management unit and covers 5,058 km^2.

Major flows and resource management issues larger than the study area were considered but only to a minor extent. Such influences as the rising Calgary population and connectivity issues with British Columbia and lands to the south and north were considered.

2.3.2. LANDSCAPE MANAGEMENT UNIT (LMU)

A landscape management unit (LMU) is a heterogeneous area in which the pattern of the mosaic of local ecosystems or land uses is repeated in similar form throughout a kilometers wide area (after Forman 1986). These landscapes may coincide with a climatic, physiographic or ecological boundary. However, landscapes are not strictly ecologically based and include human use and modification of the area. LMUs are areas which have developed under relatively similar disturbance regimes (both human and natural disturbances) and can be expected to respond to management interventions in a similar manner.

The landscapes on the accompanying Landscape Management Unit map were identified using the following input digital data sources:

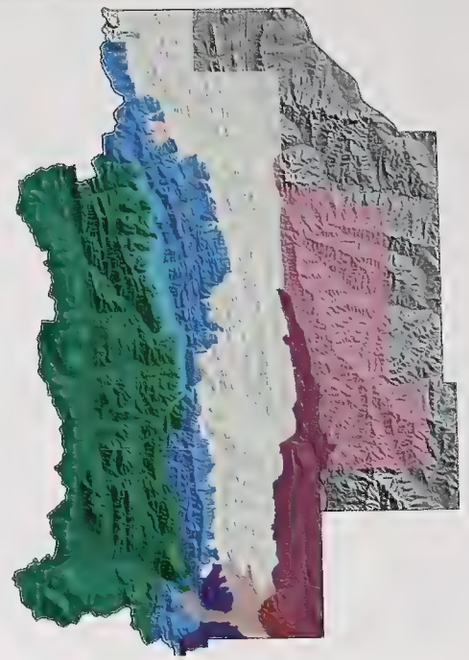
Natural Subregions
Physical Land Classification @ 1:50 000
Ecological Land Classification @ 1:100 000
Digital Terrain Model
LANDSAT TM
Orthophotographs
Alberta Vegetation Inventory

Wherever possible, landscapes have been delineated on the basis of natural subregion or physical or ecological boundaries. The boundaries have been set where a visible change in land cover pattern is clearly identified on either the Landsat or orthophoto imagery or the land cover map. Boundaries have also been identified where major flows of species, fire, water, etc. are interrupted, such as at the Livingstone Range. In most cases, the landscape delineation results in units that cross public/private land boundaries as long as the pattern is continued on both sides of the administrative boundary. Unity of pattern, therefore, is a defining characteristic of landscapes.

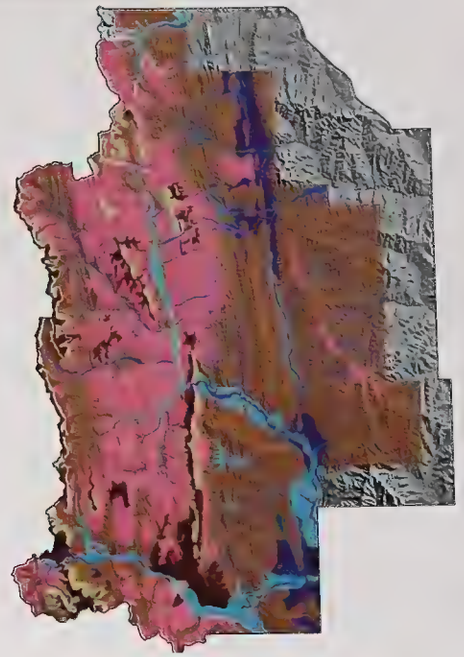
The landscapes also reflect a need to identify pragmatic planning areas. While further stratification within the various landscapes is possible, this could result in an unwieldy number of units which would ultimately be less useful for planning purposes. Therefore, some units that display a limited degree of vegetation composition difference (e.g., the north and south Porcupine Hills) were aggregated into one landscape unit.

Analysis and derivation of land pattern objectives or landscape design criteria have been developed for both the region and individual landscapes. In addition, it is anticipated that landscape specific operating ground rules will be developed in the future to replace the current provincial wide rules.

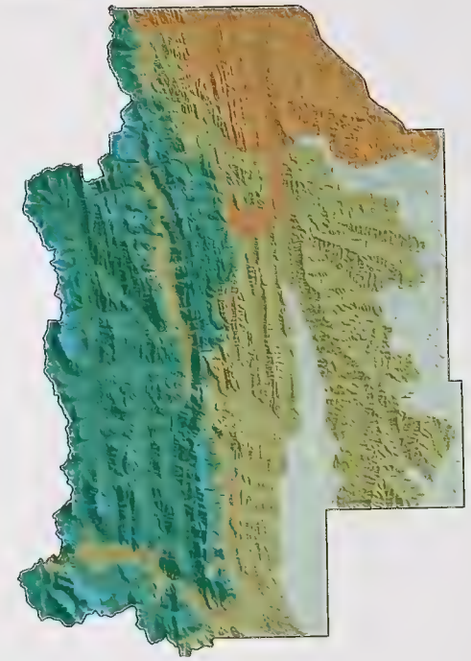
Physical Land Classification



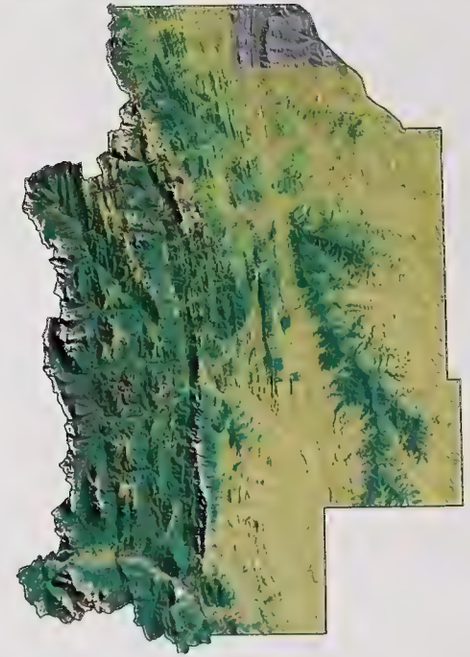
Ecological Land Classification



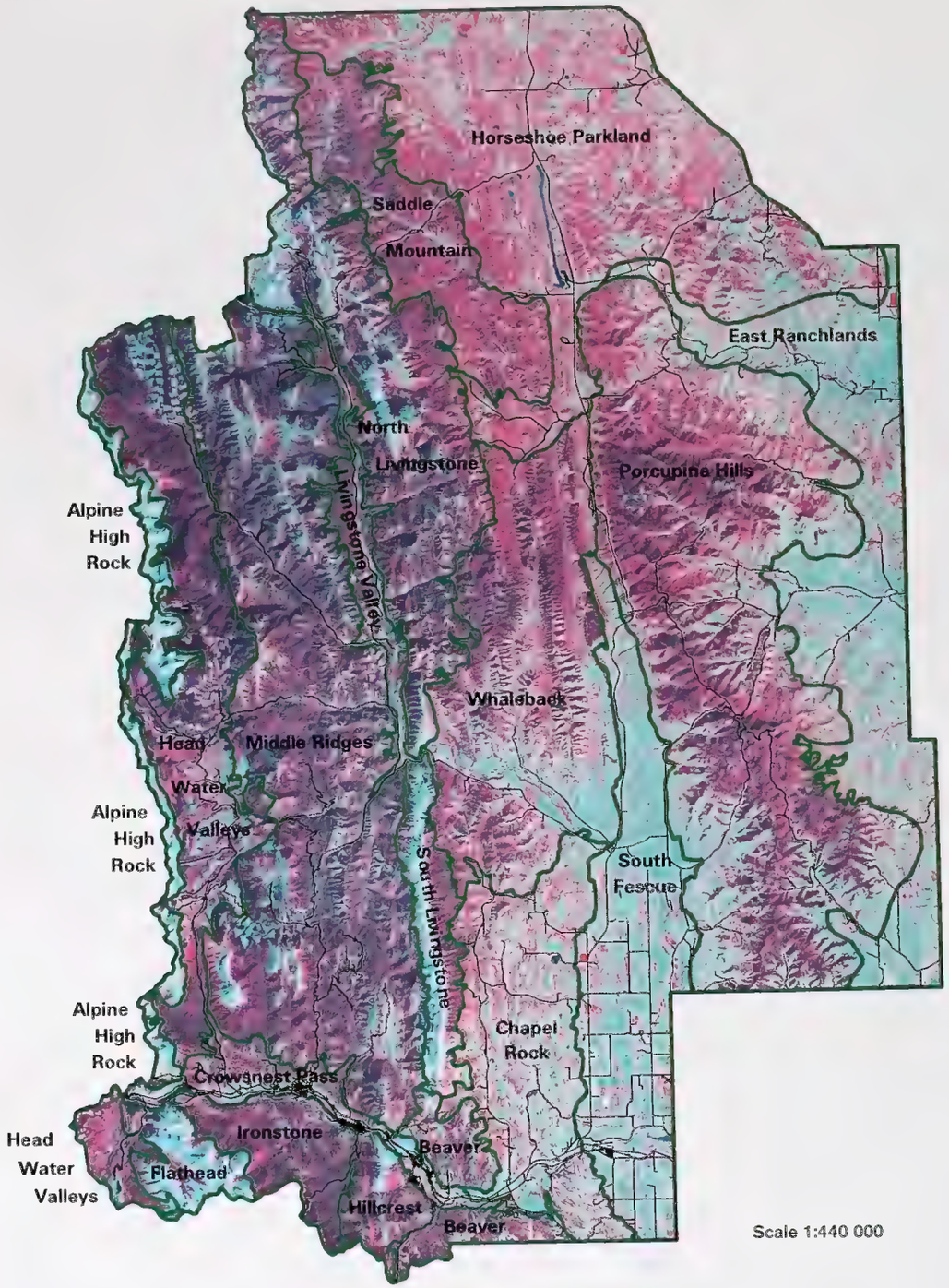
Natural Sub Regions



Alberta Vegetation Inventory



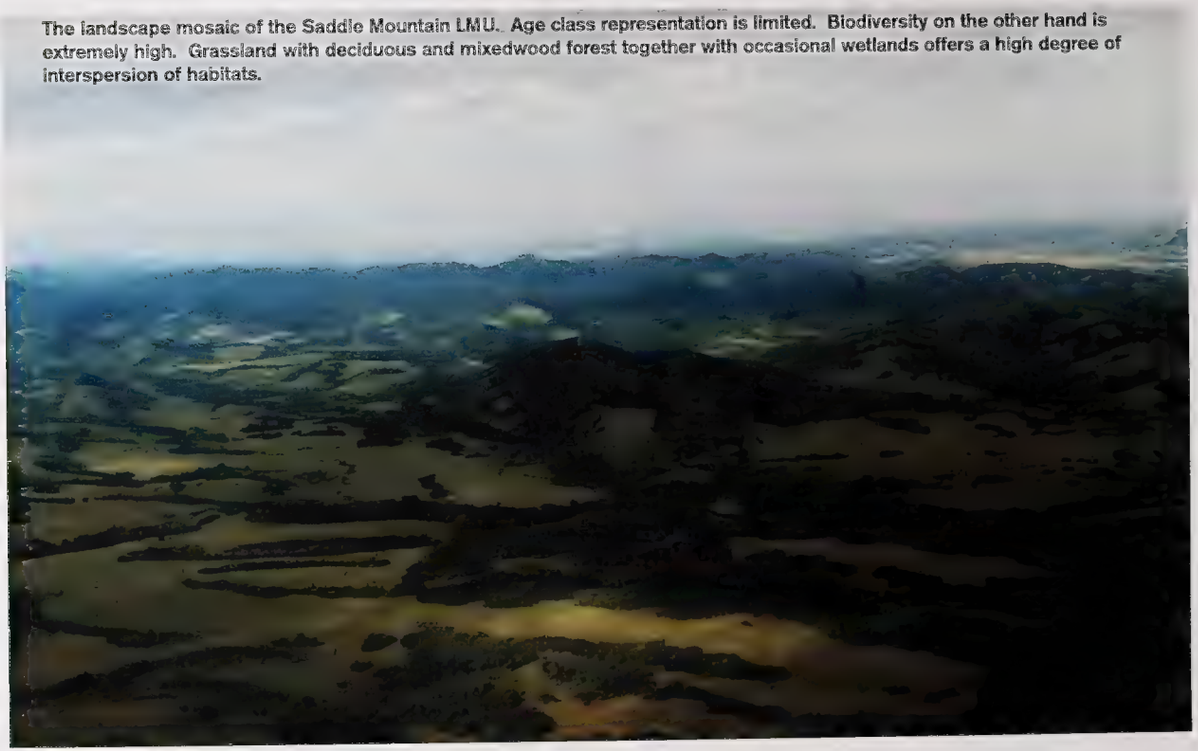
Landsat TM with Landscape Management Unit Boundaries



The following landscapes were delineated in the study area:

Table 1. Landscapes of the Study Area

Landscape	Area (ha)	% of Study Area
Alpine High Rock	8,277	1.64%
Head Water Valleys	34,357	6.79%
Flathead	5,351	1.06%
Crowsnest Pass	7,628	1.51%
Middle Ridges	73,560	14.54%
Ironstone	8,609	1.70%
Hillcrest	4,740	0.94%
North Livingstone	37,960	7.50%
Livingstone Valley	7,205	1.42%
South Livingstone	7,888	1.56%
Beaver	7,356	1.45%
Horseshoe Parkland	67,036	13.25%
Saddle Mountain	19,633	3.88%
Whaleback	39,524	7.81%
Chapel Rock	26,085	5.16%
South Fescue	29,170	5.77%
Porcupine Hills	81,560	16.12%
East Ranchlands	39,899	7.89%
Total	505,837	100%



The landscape mosaic of the Saddle Mountain LMU. Age class representation is limited. Biodiversity on the other hand is extremely high. Grassland with deciduous and mixedwood forest together with occasional wetlands offers a high degree of interspersion of habitats.

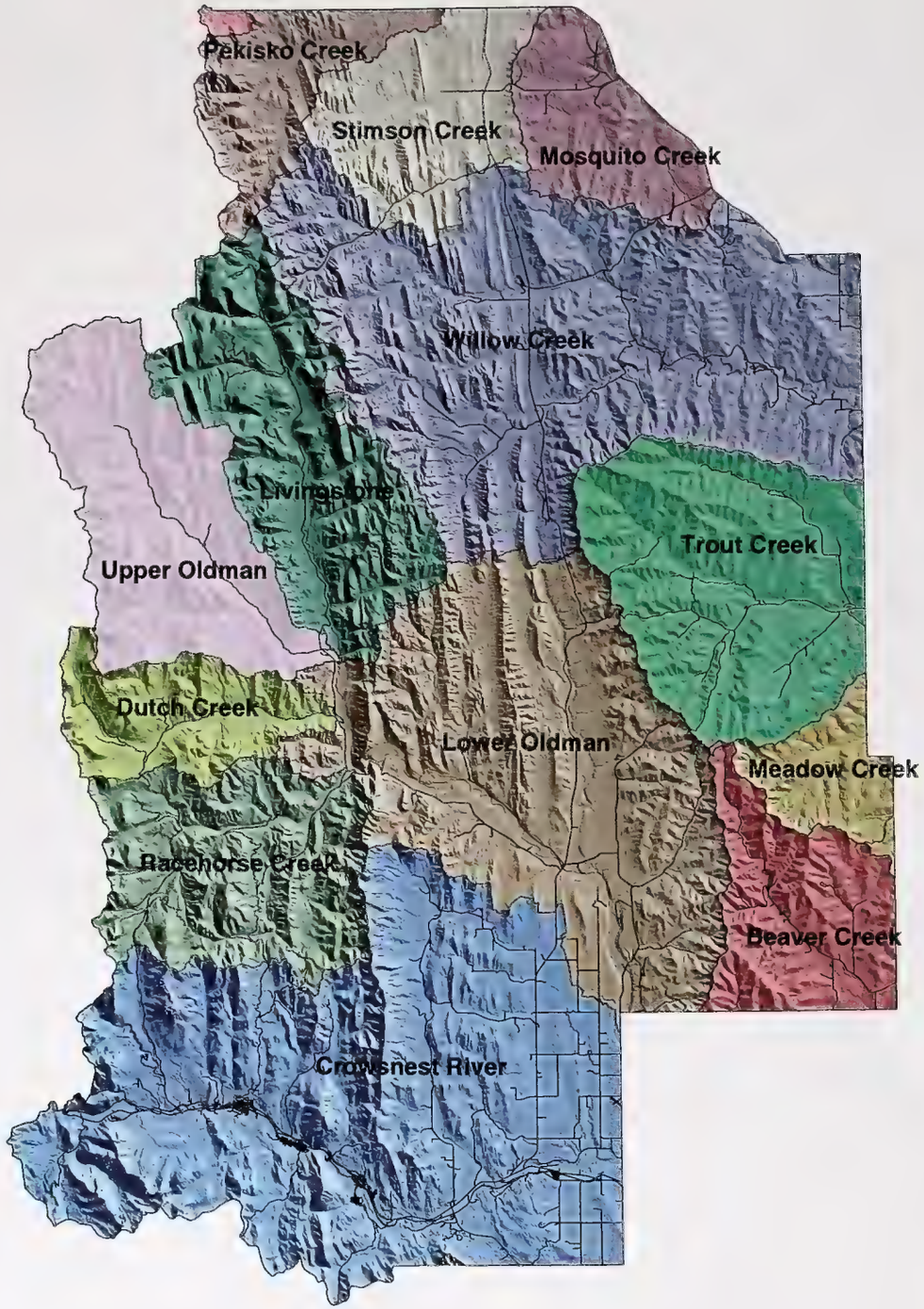
Riparian vegetation in the montane along the Oldman River in the Whaleback LMU

Continuous coniferous forest cover in the Middle Ridges LMU

The patchy montane landscape of the Crowsnest Pass

Coniferous forest interspersed with deciduous & grassland patches in the Beaver LMU

Watershed Sub Basins



2.3.3. WATERSHED SUB BASINS

Analysis of hydrological impacts or other fluvial processes requires the stratification of the region by watershed sub basins. Basins were chosen to approximate basins of interest from a fisheries standpoint. Watershed sub basins were analyzed for general risk to the basin in terms of erosion, water quality and changes in peak flow. Design criteria need to be established for individual basins.

The following sub basins were delineated:

Beaver Creek
Crowsnest River
Dutch Creek
Livingstone River
Lower Oldman River
Meadow Creek
Mosquito Creek
Pekisko Creek
RaceHorse Creek
Stimson Creek
Trout Creek
Upper Oldman River
Crowsnest River
Willow Creek

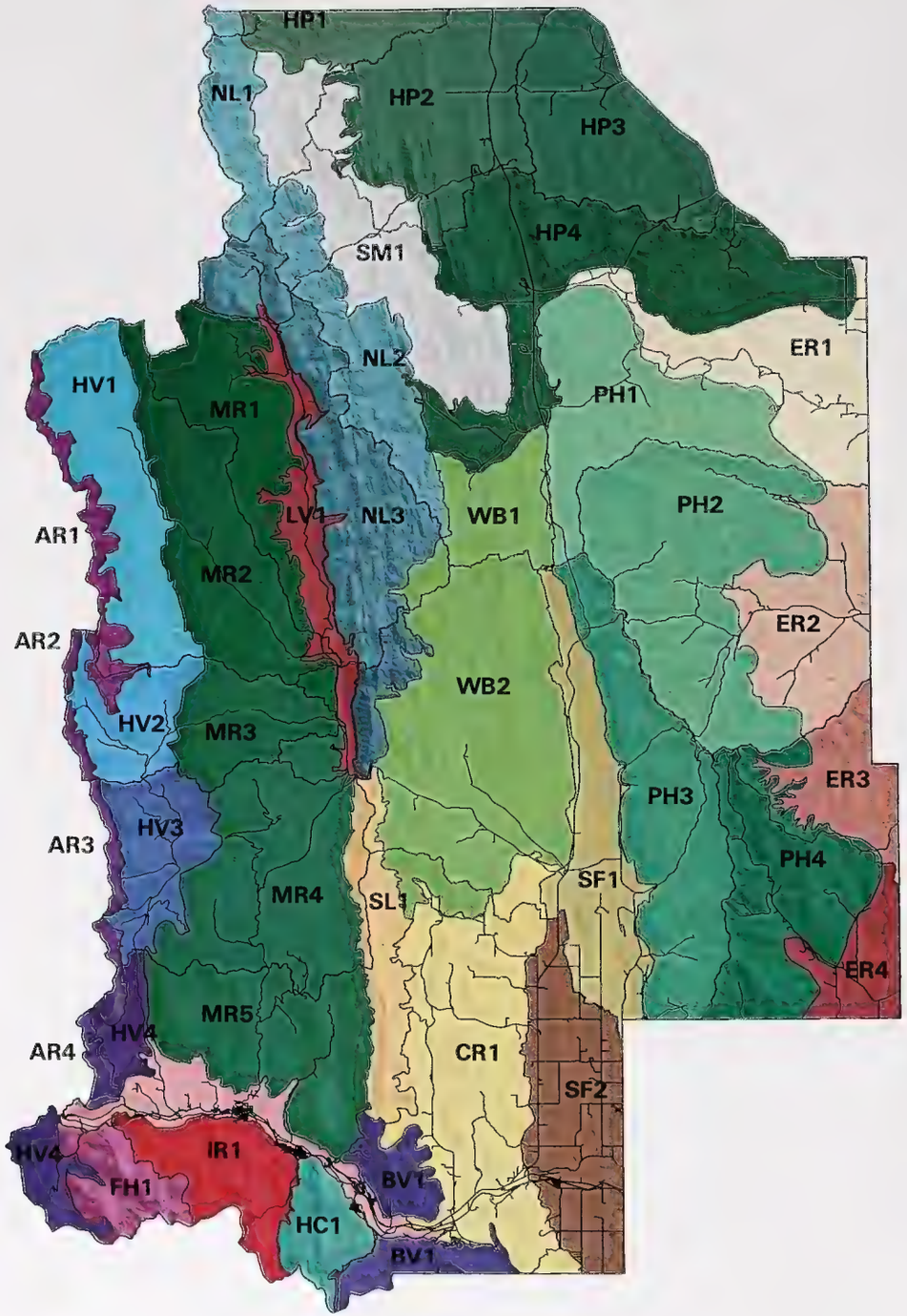
2.3.4. LANDSCAPE COMPARTMENTS

While Landscape Management Units are, in a general sense, expected to respond to management in a similar manner, some management objectives may extend beyond the landscape unit. For example, fisheries managers may be particularly concerned with the management of a sub basin such as the Upper Oldman River. Management requirements, however, may vary within the basin due to physiographic and vegetation conditions. In order to address the need to coordinate watershed management with other requirements at the landscape management unit level, Landscape Compartments have been identified. The compartments are a combination of the LMUs and sub basins. The size of the units make them particularly useful for operational and general development planning. It is expected that landscape compartments within a LMU will be used for temporal sequencing of timber harvesting in order to reduce the extent of activities, if not the area. They also are useful planning units for access management and visual resource management as they often contain view sheds. The following compartments have been identified:

Table 2. Landscape Compartments

Area in hectares	Compartment
1,664	AR 1 Alpine High Rock | Crowsnest River
1,703	AR 2 Alpine High Rock | Dutch Creek
3,489	AR 3 Alpine High Rock | Upper Oldman
1,420	AR 4 Alpine High Rock | RaceHorse Creek
5,830	HV 1 Head Water Valleys | Crowsnest River
6,294	HV 2 Head Water Valleys | Dutch Creek
14,540	HV 3 Head Water Valleys | Upper Oldman
8,115	HV 4 Head Water Valleys | RaceHorse Creek
5,343	FH 1 Flathead | Crowsnest River
7,628	CP 1 Crowsnest Pass | Crowsnest River
16,591	MR 1 Middle Ridges | Crowsnest River
7,522	MR 2 Middle Ridges | Dutch Creek
16,598	MR 3 Middle Ridges | Upper Oldman
11,658	MR 4 Middle Ridges | Livingstone
20,948	MR 5 Middle Ridges | RaceHorse Creek
8,602	IR 1 Ironstone | Crowsnest River
4,738	HC 1 Hillcrest | Crowsnest River
5,918	NL 1 North Livingstone | Pekisko Creek
11,340	NL 2 North Livingstone | Willow Creek
3,136	NL 3 North Livingstone | Lower Oldman
17,563	NL 4 North Livingstone | Livingstone
7,011	LV 1 Livingstone Valley | Livingstone
7,888	SL 1 South Livingstone | Crowsnest River
7,360	BV 1 Beaver | Crowsnest River
15,986	HP 1 Horseshoe Parkland | Mosquito Creek
17,874	HP 2 Horseshoe Parkland | Stimson Creek
5,196	HP 3 Horseshoe Parkland | Pekisko Creek
27,941	HP 4 Horseshoe Parkland | Willow Creek
19,633	SM 1 Saddle Mountain | Willow Creek
6,870	WB 1 Whaleback | Willow Creek
32,655	WB 2 Whaleback | Lower Oldman
26,084	CR 1 Chapel Rock | Crowsnest River
13,805	SF 1 South Fescue | Lower Oldman
15,363	SF 2 South Fescue | Crowsnest River
17,117	PH 1 Porcupine Hills | Willow Creek
20,064	PH 2 Porcupine Hills | Lower Oldman
27,549	PH 3 Porcupine Hills | Trout Creek
16,829	PH 4 Porcupine Hills | Beaver Creek
14,681	ER 1 East Ranchlands | Willow Creek
12,761	ER 2 East Ranchlands | Trout Creek
6,994	ER 3 East Ranchlands | Meadow Creek
5,392	ER 4 East Ranchlands | Beaver Creek

Landscape Compartments



2.3.5. ECOSITE PHASE AND A COMMON SPATIAL VOCABULARY

The study describes several future alternative scenarios for the area as well as evaluating the impacts of those scenarios at different points in time. A common spatial vocabulary was required in order to ease the comparison of alternatives and to reduce data processing requirements. A common method of describing the landscape provided a uniform set of inputs for all impact models whether they are for single species potential habitat, visual quality or any other impact of interest. As approximately 20 impact models were needed to be run on ten different alternatives and points in time, the practical importance of providing a common language for the input maps is clear. Should separate input spatial data sets be required for each impact model, the required data processing would be overwhelming. Therefore, ecosite phase by decade of origin was used as the language to describe both the existing conditions as well as any alternative at any point in time.

Ecosite Phase (after Archibald et al, 1996) is the smallest unit to be considered in the project and approximates the stand level scale. These patches represent the most detailed landscape classification and are used to describe both existing conditions and future scenarios. The ecosite phase is the vegetative expression on an ecosite. These local ecosystems have developed under similar environmental conditions (climate, moisture and nutrient regime). Ecosites are groups of one or more ecosite phases that occur within the same portion of the edatope grid (moisture/nutrient grid). Ecosites have similar landform, climate, nutrient and moisture regimes, as well as potential vegetation, successional pathways, site productivity and, at a local scale, response to management.

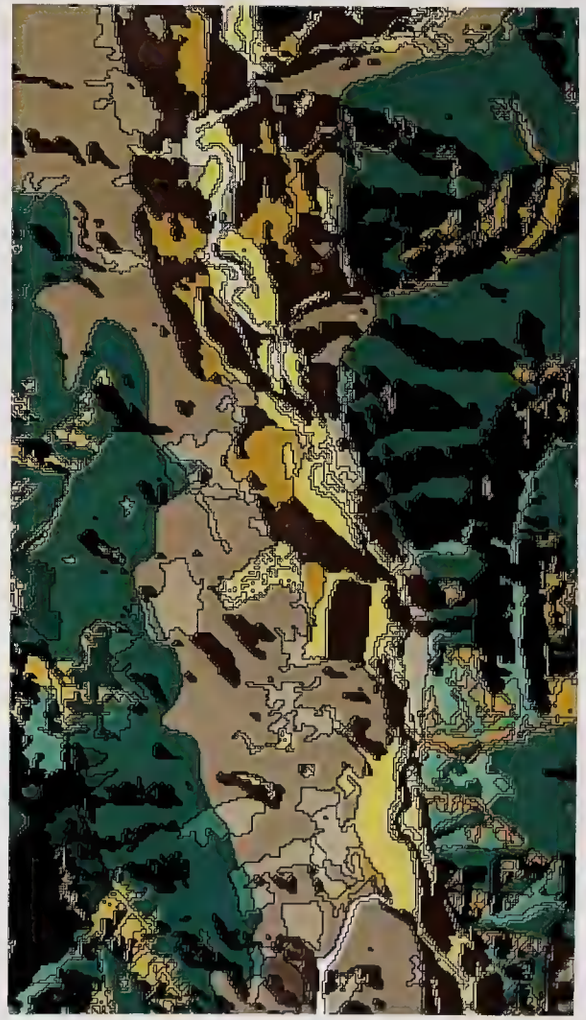
Ecosite phase is an extremely useful characterization of both the site and its vegetation. Together with successional trajectories under various types of disturbance, it allows for projection of site conditions into the future. This projection in not possible using only the Alberta vegetation inventory.

The procedure for identifying an ecosite phase has two stages; forest cover classification and subsequently, ecosite phase classification. The detailed methodology for both procedures is described in the Disturbance and Pattern report. The Field Guide to Ecosites of Southwestern Alberta (Archibald et al, 1996) was the primary reference document for the ecosite phase classification. The following data were used in the classification:

Alberta Vegetation Inventory
Digital Elevation Model
Aspect
Slope
Slope Position
Forest Cover
Natural Subregions
Physical Land Classification @ 1:50 000

Ecosite phases classification models were designed for three natural subregions, Subalpine (9 classes), Montane (12 classes) and Grasslands (17 classes). As boundaries between the subregions were not always abrupt, additional classes, namely Transitional Subalpine (10 classes) and Transitional Montane (2 classes) regions were subsequently identified and models were developed for them separately. The Montane models were applied to both the Foothills Parkland (12 classes) and Foothills Fescue (12 classes) regions. Ecosite phases, which have been classified in the study area, are listed in the appendix.

Detail of Ecosite Phase



3. Existing Conditions and Alternative Future Scenarios

The existing landscape is a shifting mosaic of various land uses and vegetation cover types. The cover and land use classes within the study area include natural vegetation areas, perennial and annual crops, residential and commercial development, transportation and infrastructure, rock and water bodies. Shifts in the configuration or pattern of these local landscape elements are occurring either through vegetational succession, by planned human intervention such as harvesting, or by disturbance events such as forest or range fires. Landscape change within the study area is influenced predominantly by transformation of native vegetation by agriculture and forestry and changes in the natural disturbance regimes, chiefly fire return intervals on upland sites and inundation frequency in riparian areas.

Future changes to the area are guided by natural disturbance, current trends, or caused by the implementation of purposeful change via plans, designs, investments, policy and regulations. This pilot study has centered on methods of describing existing and potential landscapes as well as evaluating the potential impacts of various landscape configurations. In order to properly test the methods, several potential alternative future scenarios were prepared, described and evaluated. The possible alternative futures will have different impacts on ecological, economic and cultural areas of interest. All future conditions were compared with the existing conditions to determine impacts.

The existing conditions are not in stasis regardless of future actions. Conservation, non–action, as well as intervention will all bring about future change with differing impacts. Using existing plans, known trends and differing sectoral emphasis, a range of future alternative scenarios has been developed and their associated impacts simulated.

In order to evaluate the future scenarios in a similar manner as well as to reduce the complexity of the evaluation process, all alternatives (including the existing conditions) have been described with a single map set and in a common spatial vocabulary. The natural vegetation areas have been described in terms of ecosite phases as previously described. Together with the origin/age of the stand, this spatial vocabulary is used to create a single set of variables which describes each alternative and which provides the input for most of the impact models.

Alternative visions of what the region might become have been articulated. In order to provide an understanding of various levels of impacts as well as to help identify individual sectoral land pattern requirements, alternatives that emphasize both current trends and a particular land use have been developed. In addition, the potential impact of a set of large disturbance events has also been modelled. Many of the scenarios are extremes (e.g., the Fibre Scenario) and not something the government views as reasonable or likely options. Alternatives have been projected and modelled at 20 and 50 years into the future. It would have been desirable to model the scenarios over a longer planning horizon (up top two full rotations) but this was not done due to time and other constraints. The range of potential alternatives has been limited and landscape designs that attempt to provide balanced alternatives have not been attempted. Rather, the tools have been tested and readied for real planning in the area.

The alternative scenarios are based on the assumption that the set of existing land use and land cover types will remain the same in the future. The alternative scenarios assume radically different management of the area and result in different landscape configuration and economies.

The existing conditions and five future alternatives at year 20 and year 50 are described in the following section. The base set of descriptors for each alternative includes the following:

Ecosite Phase Map
Age Class Map
Harvest Areas and Access
Coniferous, Deciduous, Mixedwood, Grassland, and Other Patch Size Distribution
Disturbance Patch Size Distribution
Ecosite Phase by Decade Patch Size Distribution
World Construction Set™ Visualization of a Portion of the Landscape

While far more comprehensive reporting is available for each alternative, the detail tends to be overwhelming and is not included in this summary report. The above simple set of descriptors provides an overview summary of the alternatives and is particularly valuable for assessing the degree of variance from existing or historical conditions. The alternatives have been delineated and presented in a highly visual way so as to make them as accessible to the public and other stakeholders as possible. Computerized panoramas and landscape flybys have also been developed for some of the alternatives. In addition to the existing conditions, the following alternatives have been developed:

THE TREND SCENARIO
Using current rules and regulations, the Trend Scenario represents the long–term future if the existing ground rules were used to determine the harvestable land base and general operations. This alternative does not actually represent the actual current plans in the area. The alternative assumes that existing protection and management policies would be continued and that forest harvesting location, intensity and extent will be based upon current policies.

THE DISTURBANCE SCENARIO
The potential that catastrophic fires similar in extent to historic events will reoccur in the area has been explored.

THE FIBRE SCENARIO
This alternative explores the future conditions, for example, if current planning is overwhelmed by economic pressures and the area is managed for the maximization of fibre production with little or no regard for other forest values (wildlife habitat, scenic quality, etc.) or existing operating ground rules.

THE PRESERVATION SCENARIO
Prescribed Burn Management
The area is managed for preservation as a quasi wilderness area. Prescribed burning is the primary management tool. This alternative will be used to identify the economic costs of a moratorium on industrial activity as well as the cost of management by prescribed burning.

THE FULL RECREATION SCENARIO
This alternative emphasizes recreation as the primary land use. A wide range of backcountry and frontcountry recreational uses will be accommodated. Fibre extraction is very limited.

An Adaptive Forest Management Alternative has not been modelled in the pilot as it would be part of a real planning exercise that may be initiated in the future. Such an alternative would attempt to harmonize the scenic, recreational, industrial, grazing and ecological concerns of the area.

The Existing Conditions

3.1. THE EXISTING CONDITIONS

The current condition of the region has been evaluated in order to provide baseline data for assessing the impacts of potential future alternatives. The following tables, maps and charts are used to provide an overview of the existing situation. Additional detailed information is found in the Disturbance and Pattern Analysis volume.

The vegetation of the area is distributed in five major natural Subregions (refer to pg 10); the fescue grassland, parkland, montane, subalpine and alpine. Within each of these, many ecosite phases are distributed. The current distribution of over 100 ecosite phase types has been mapped. In order to visualize the data, the following map of ecosite phases is grouped into broad categories. A very large portion of the study remains in natural vegetation. The patch size distribution of coniferous, deciduous, mixedwoods and grassland patches is indicated in Figure 6.

The vast majority (87.3%) of the forested area falls in the age classes with origins between 1860 and 1950. Almost all stands in the area are of fire origin. The area is subject to extremely large fire events during short periods of time with 55% of the forested area burnt during the period 1890 – 1930. Fully 22% burnt in the decade 1910 – 1919 alone. The analysis has been based on forest origin data.

Human use of the region has altered natural disturbance processes and significantly changed natural vegetation cover patterns in many portions of the study area. While the degree of influence of interventions such as fire control is difficult to determine, the areal extent of major human uses are more readily measured. Table 3 indicates the percentage of the study area in various anthropogenic land cover types.

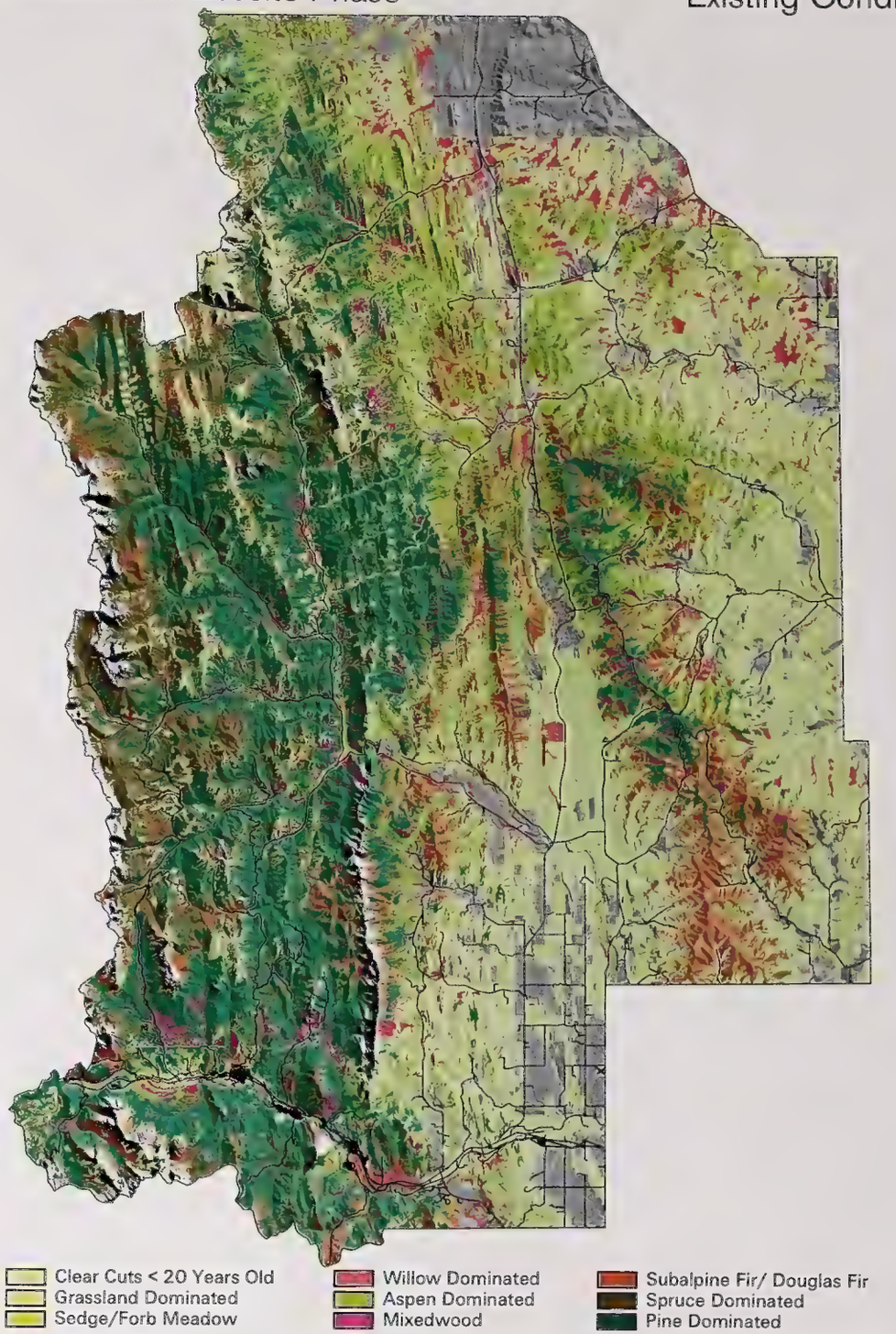
This table indicates that, on a regional basis, man has heavily modified almost ten percent of the area. The cover type with the largest areal extent is perennial forage crops that have been converted from native vegetation. Areas that have been clearcut at some time in the last 120 years account for just over two percent of the area. Historical clearcuts are those which are now considered forested and may date back as far as 1870. It is likely that the total area of historical cutting is not captured in existing inventory. Annual crops account for only 0.37% of the area. Human settlements of some form (including rural, residential and farmsteads) account for 0.23% (1,182 ha) of the study area.

Much of the study area is easily accessible by roads and trails. There is over 1,280 km of roads in the area not including truck trails. There are over 6,000 km of trails and cutlines in the area. These range in size from seismic lines and minor logging roads to little more than horse trails. A major rail line and a major highway (#3) run through the Crowsnest Pass. Highway #22 runs north–south along the west side of the Porcupine Hills.

The use of the region for forest production dates to the last century (McMillan,1909) when operations concentrated mainly in the vicinity of the Crowsnest Pass. However, the vast majority of the area has never been cut and continuous forest cover is present over much of the region. Recent forestry operations have concentrated in the Head Water Valley LMU where the impact on patch size, landscape connectivity, age class distribution, species composition, visual quality and long–term site productivity has been high. Significant cutting has also occurred in the Porcupine Hills LMU. A dispersed system of alternate patch clear cutting is the standard silvicultural system in place throughout most of the region.

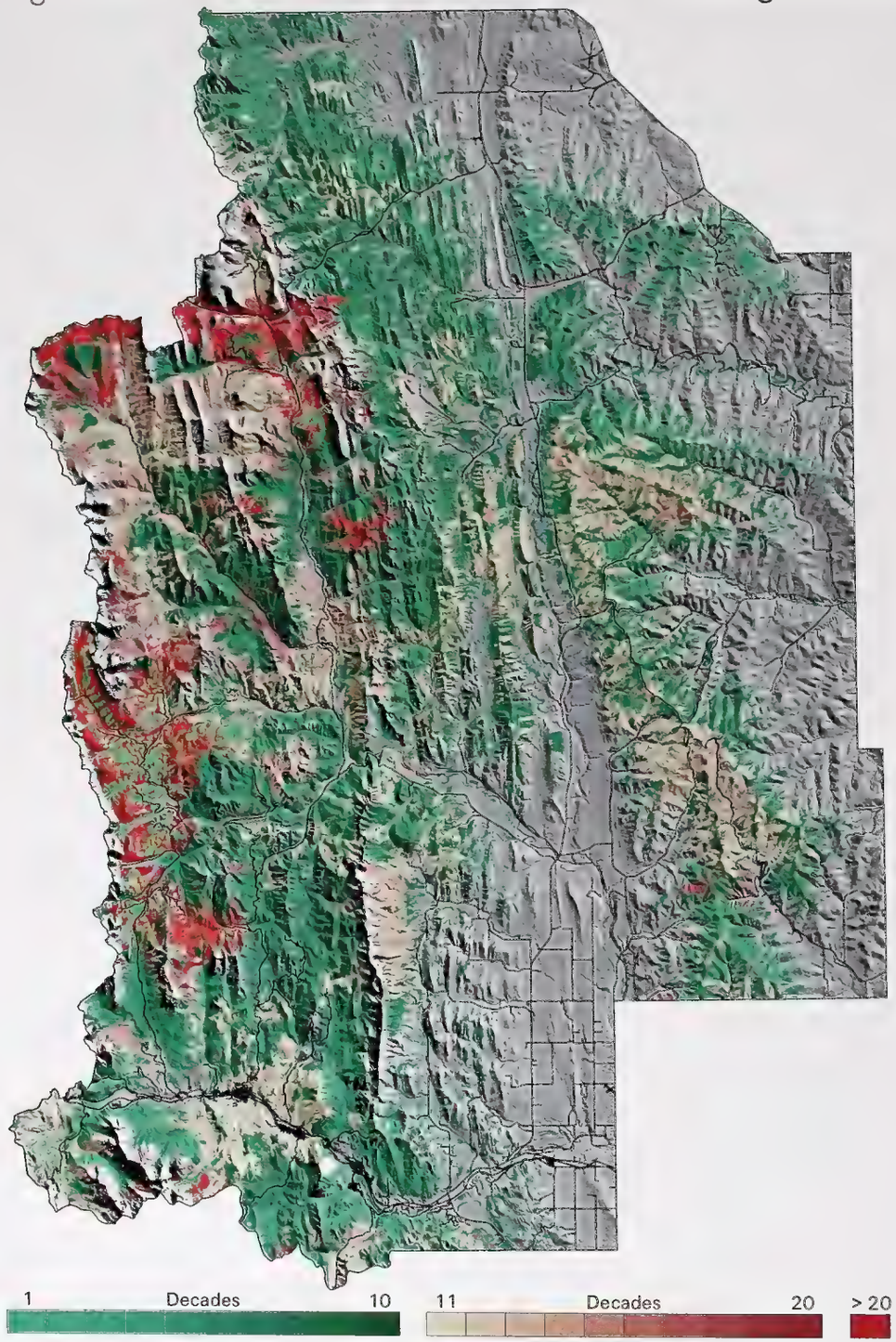
Table 3. Areal Extent of Anthropogenic Land Cover Types in Study Area

Land Cover Type	Area (ha)	% of Study Area
Annual Crops	1,894.06	0.37%
Perennial Forage Crops	33,744.25	6.67%
Gravel Pits/Surface Mines	725.19	0.14%
Rural Residential	153.63	0.03%
Hamlets, Villages and Towns	520.25	0.10%
Non–veg ROWs	782.19	0.15%
Farmsteads	509.00	0.10%
Plant Sites/Sewage Lagoons	99.63	0.02%
Industrial Reclamation–Vegetated	218.31	0.04%
Herbaceous Clearcuts	3,739.38	0.74%
Historical Clearcuts	6,412.00	1.27%
TOTAL	42,385.88	9.64%



Age Class

Existing Conditions



Access

Existing Conditions

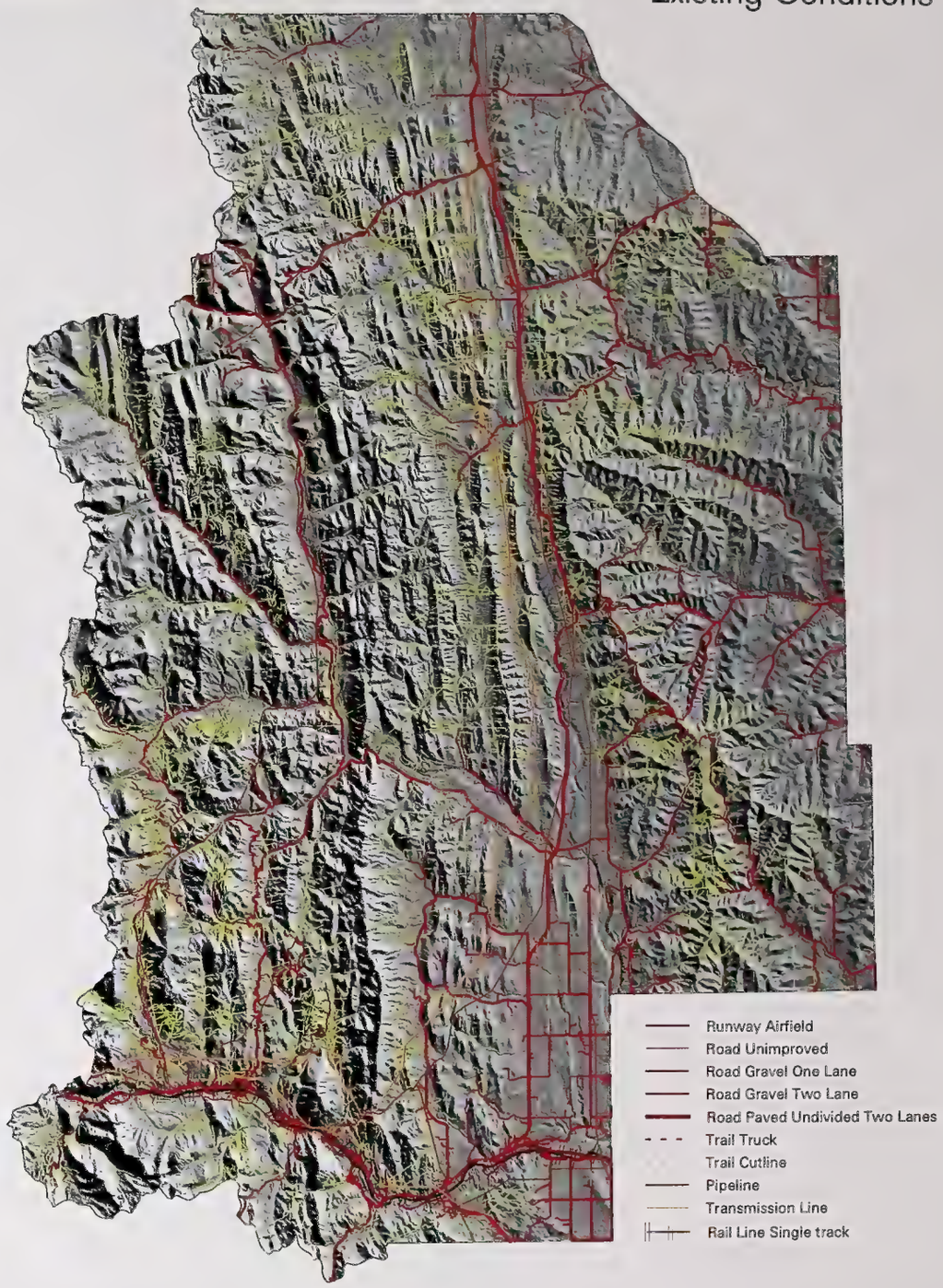


Figure 6. Coniferous, Deciduous, Mixedwood, Grassland, Other Patch Size – Existing

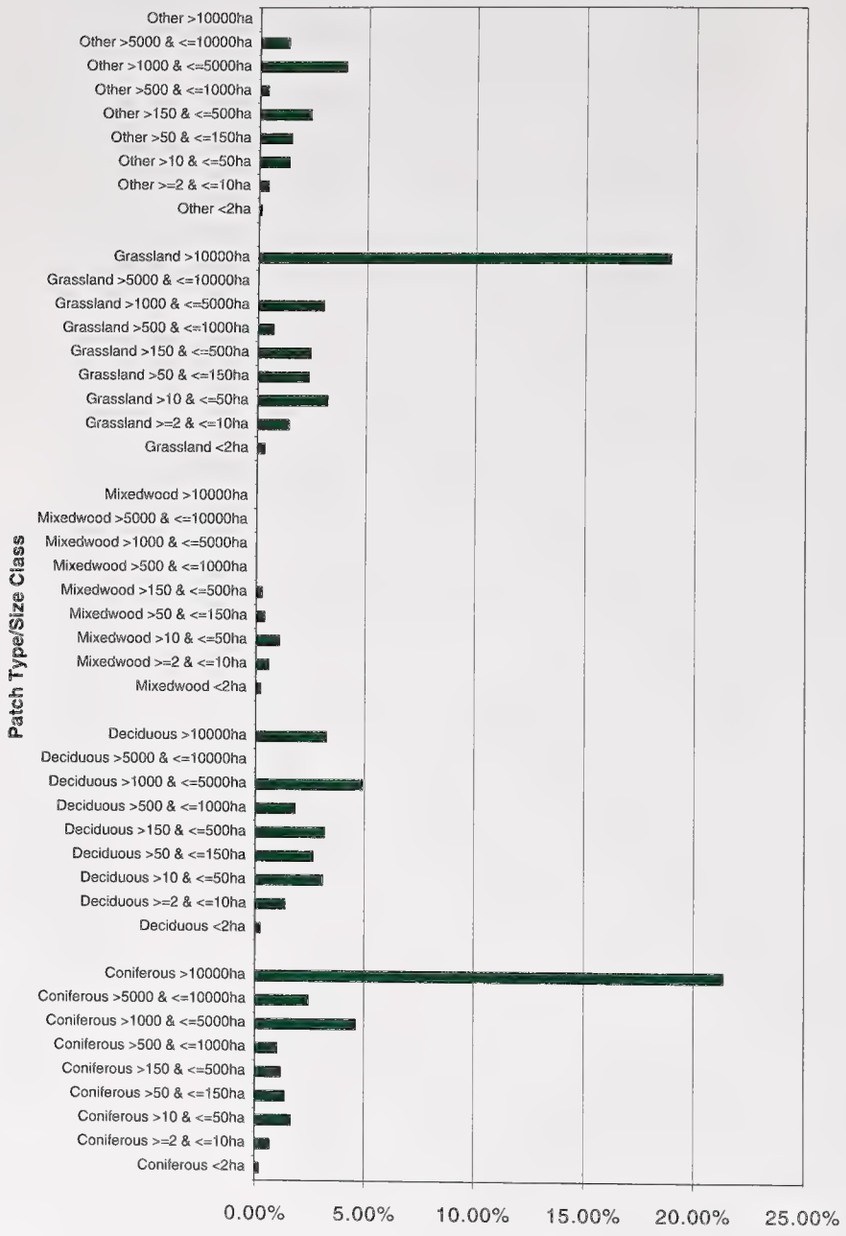


Figure 7. Regional Age Class Distribution – Existing

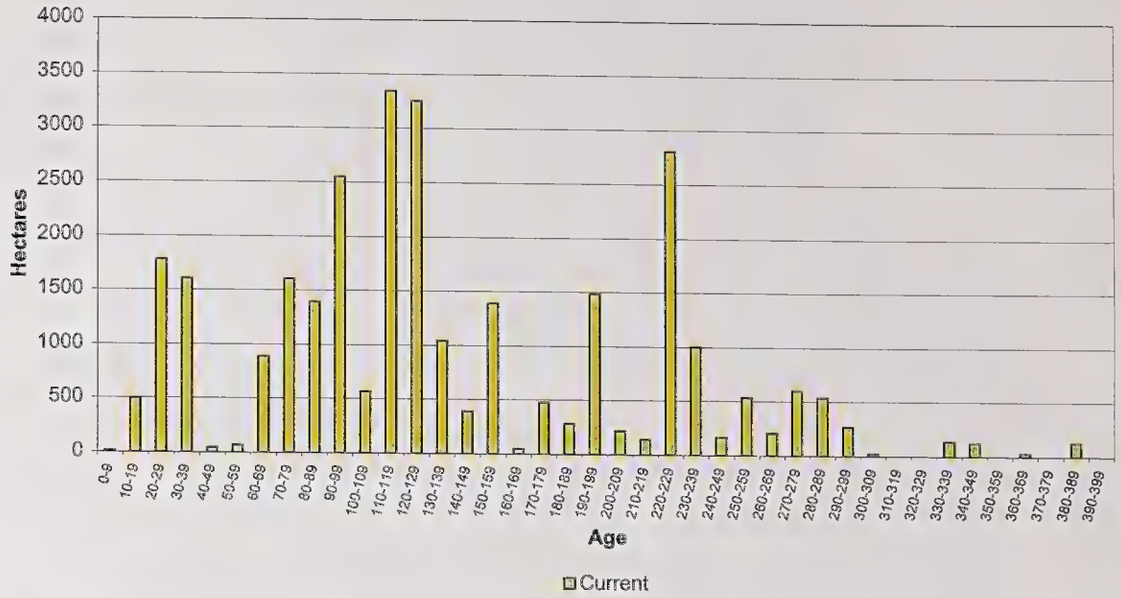


Figure 8. Disturbance Patch Size – Existing

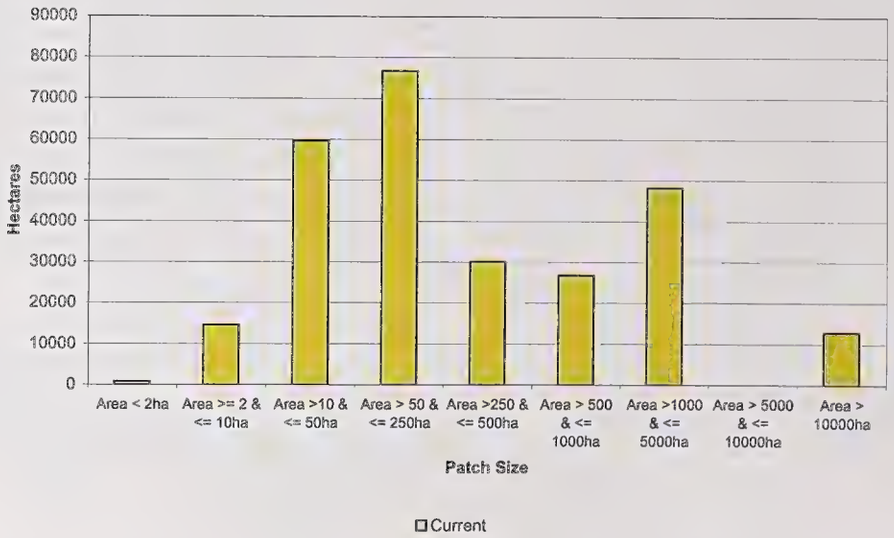
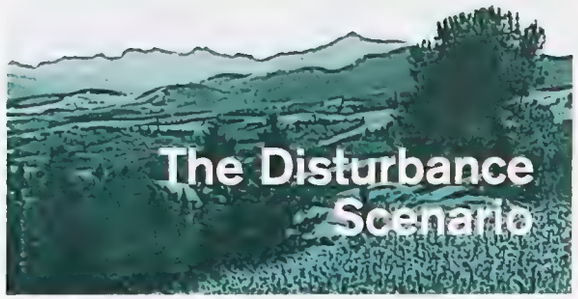


Figure 9. Visualization – West of Livingston Range – Existing



The Disturbance Scenario

3.2. THE DISTURBANCE SCENARIO

Landscape patterns and processes are closely related to disturbance regimes. In the Southern Rockies study area, fire, insects, disease, wind, avalanches and landslides are the major natural disturbances that have occurred for thousands of years and which have given rise to the current landscape structure. Until recent years, when fire control has become effective, the overwhelming mechanism for disturbance and subsequent forest origin in the Southern Rockies was fire (Johnson, E.A., and G.I. Fryer 1987, Day 1972). Fire has also been the dominant disturbance force in the grassland and shrub communities of the foothill parklands and prairies.

The Disturbance Scenario has been prepared to illustrate the potential impacts of catastrophic fire events in the study area. This alternative was determined by an examination of historical disturbance regimes and is similar in extent to the set of disturbance events that occurred during the period 1910 to 1930. These were the two consecutive decades that had the most area burned in the last one hundred years. During these years, over 97,000 hectares burned (over 36 percent of the total forested area). This does not include the area of grassland that undoubtedly burned in association with the forest fires.

The impacts that such extensive disturbance might cause to wildlife, timber and grazing supply, stream flow and visual quality are likely to be significant and need to be investigated. The very real possibility that similar events may reoccur requires that the implications of such rapid and wide spread change be known and addressed.

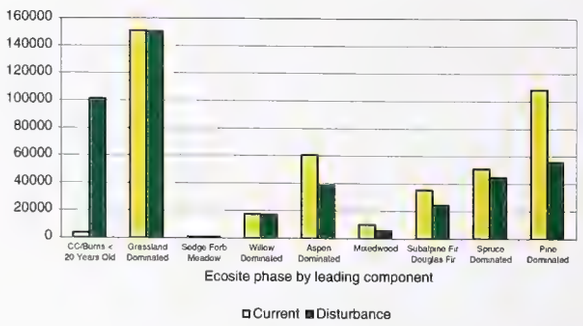
The alternative identifies which landscape patterns might evolve under such conditions and will inform other alternatives which intend to mimic or complement natural disturbance regimes. Should such large events be socially unacceptable (and it is highly likely that that is the case), then efforts will have to be made to reduce the likelihood of their occurrence.

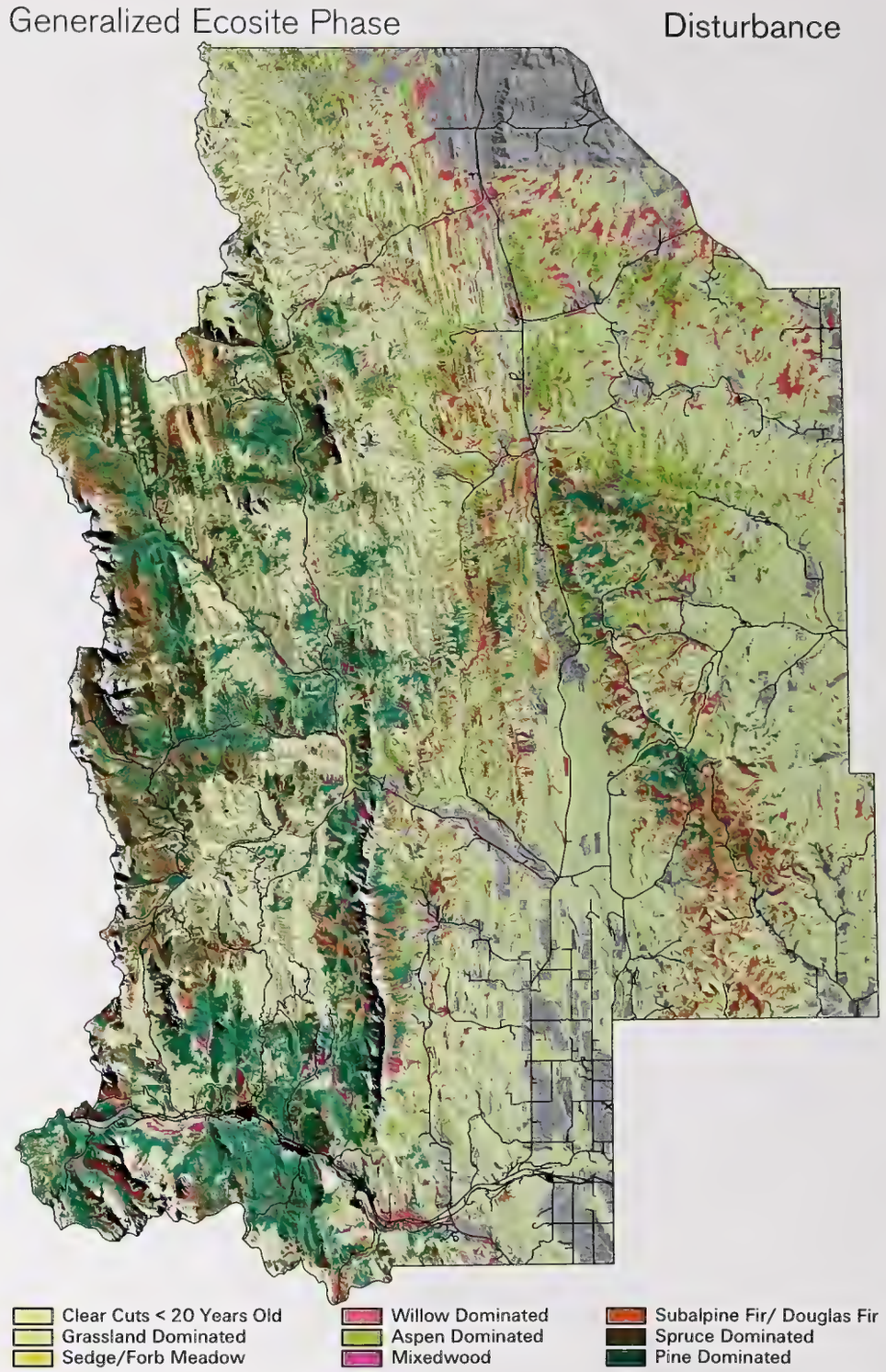
The following are the assumptions of this alternative:

- the area that burned in the period 1910 to 1929 was used to set the maximum area burned in the alternative
- the areas were "burned" in two stages (ten years apart)
- no harvesting or salvage operations occurred under this alternative
- regeneration was as per current fire regeneration rules
- regeneration lag times, as indicated in the Trend Scenario, are used
- Oil and gas operations continued unaffected

The following chart indicates the distribution of ecosite phases grouped by leading component. Complete reporting on all ecosite phases (uncollapsed) is available.

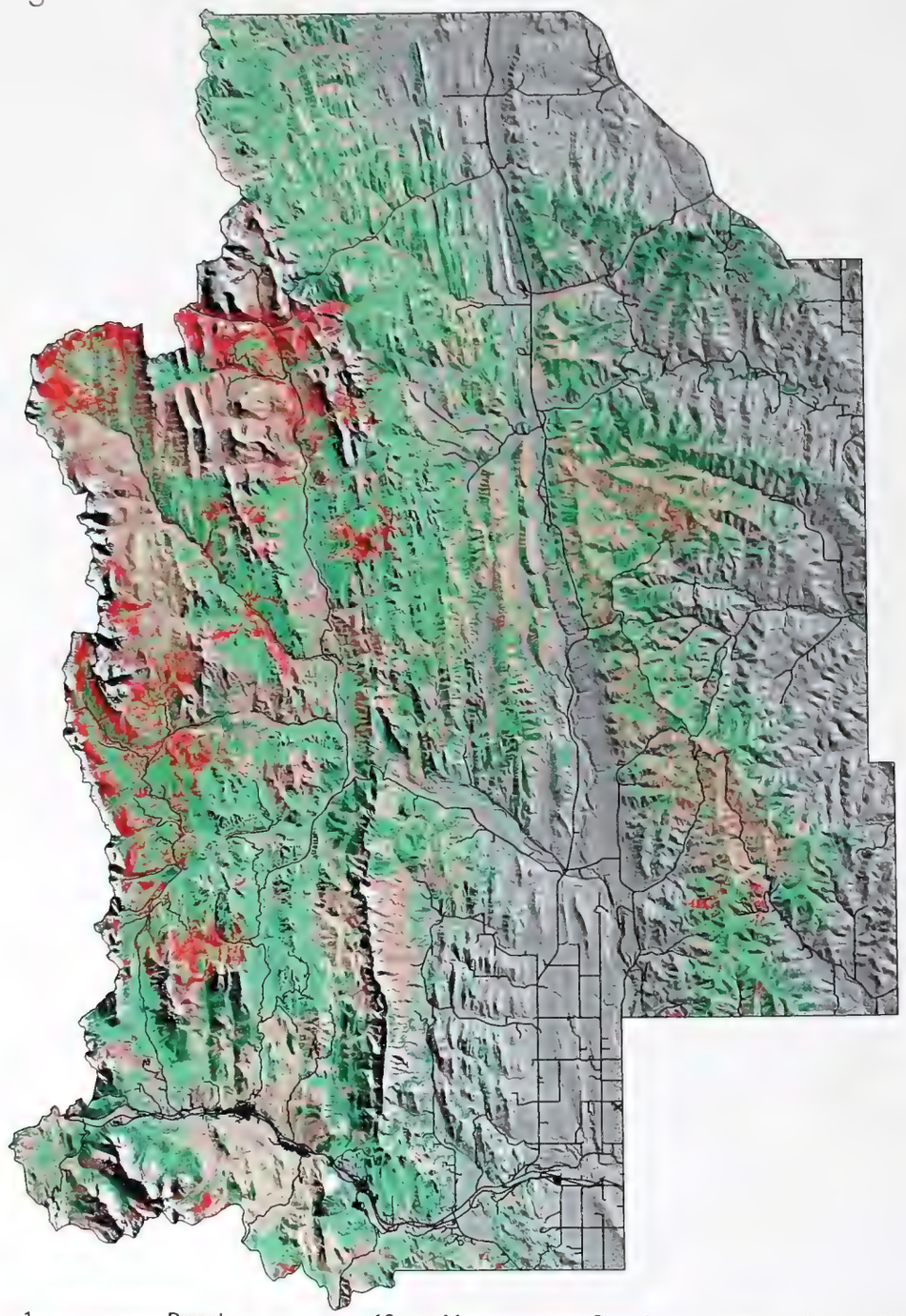
Figure 10. Ecosite Phase by Leading Component – Disturbance





Age Class

Disturbance



Wildfires and Access

Disturbance

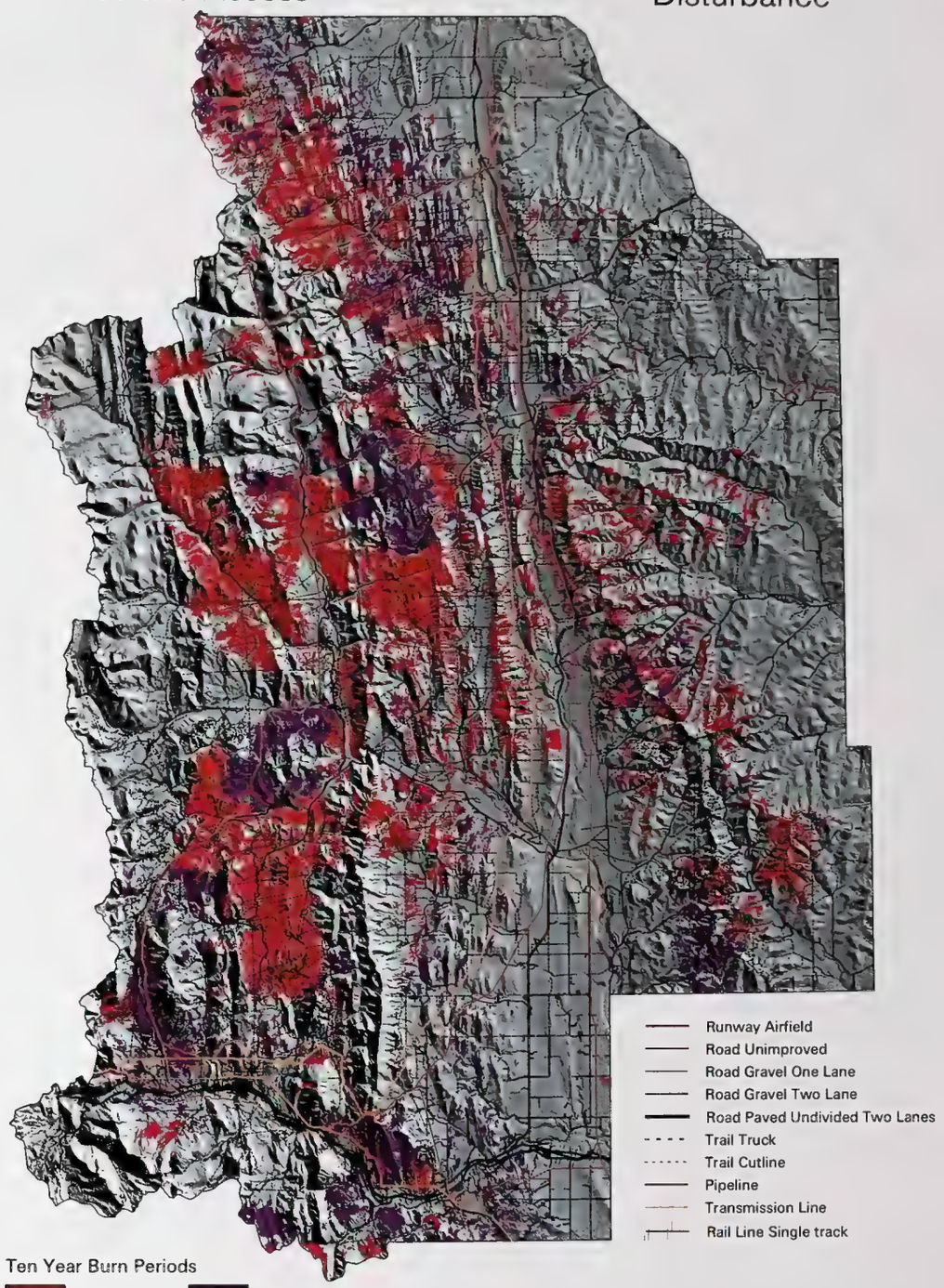


Figure 11. Coniferous, Deciduous, Mixedwood, Grassland, Other Patch Size – Disturbance

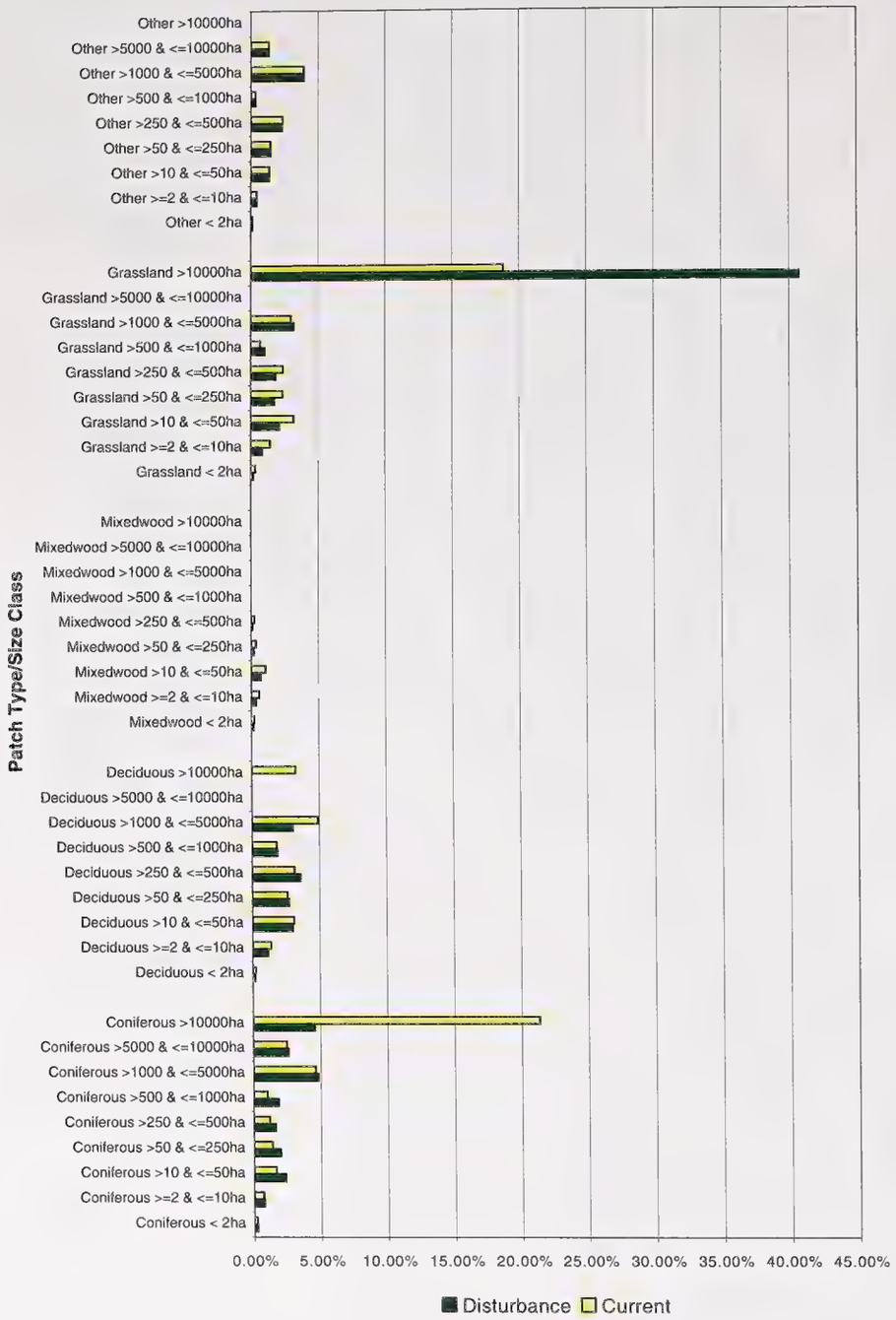


Figure 12. Regional Age Class Distribution – Disturbance

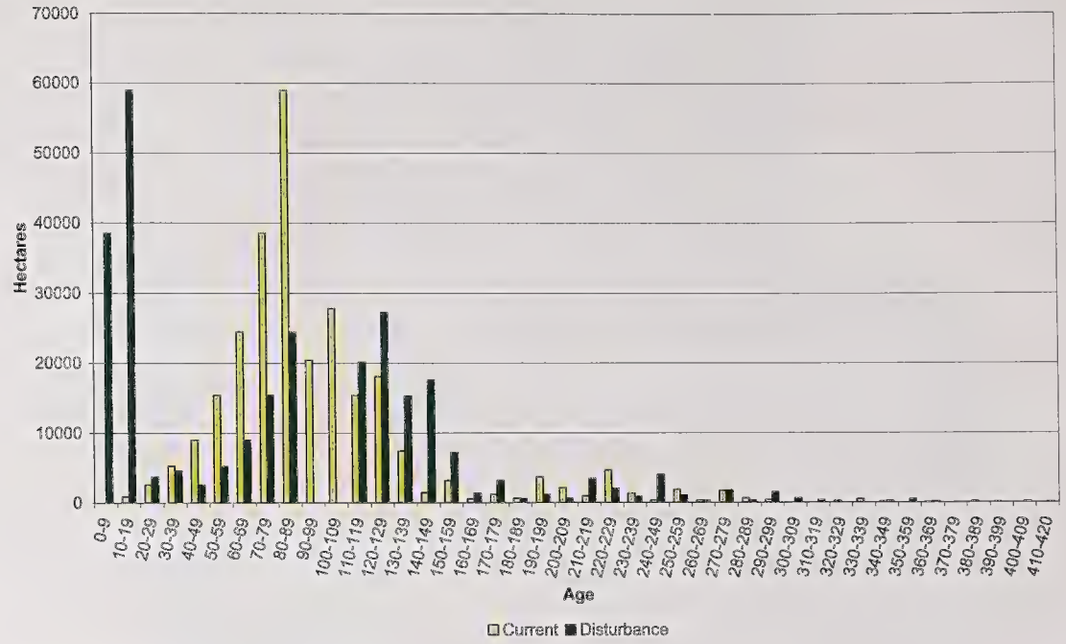


Figure 13. Disturbance Patch Size – Disturbance

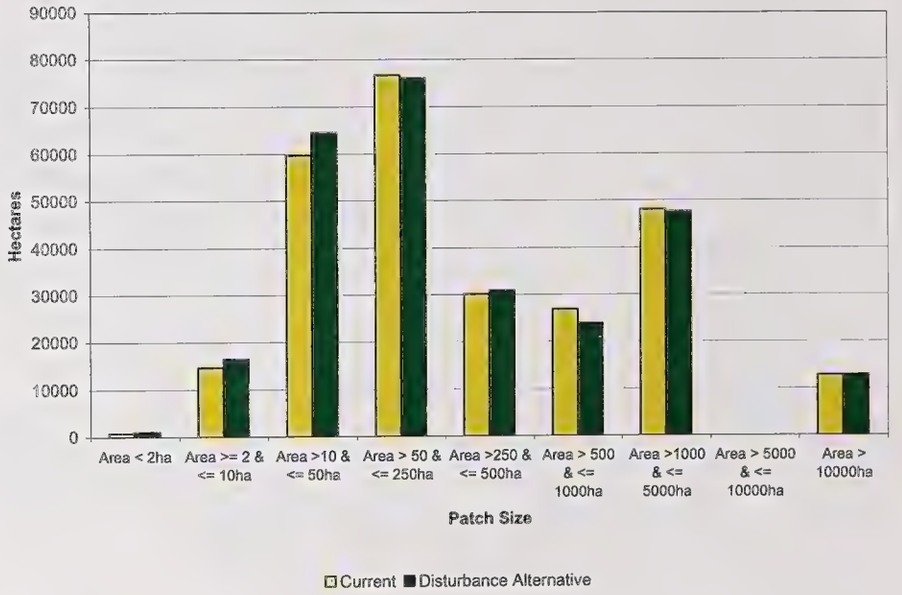


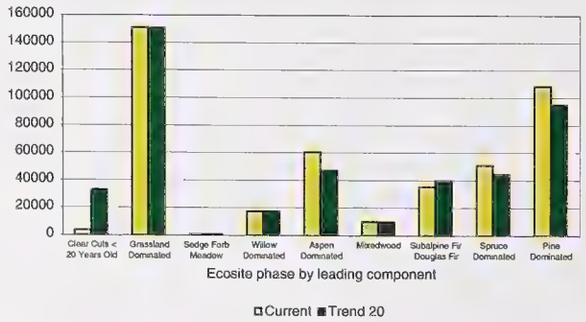
Figure 14. Visualization — West of Livingston Range — Disturbance

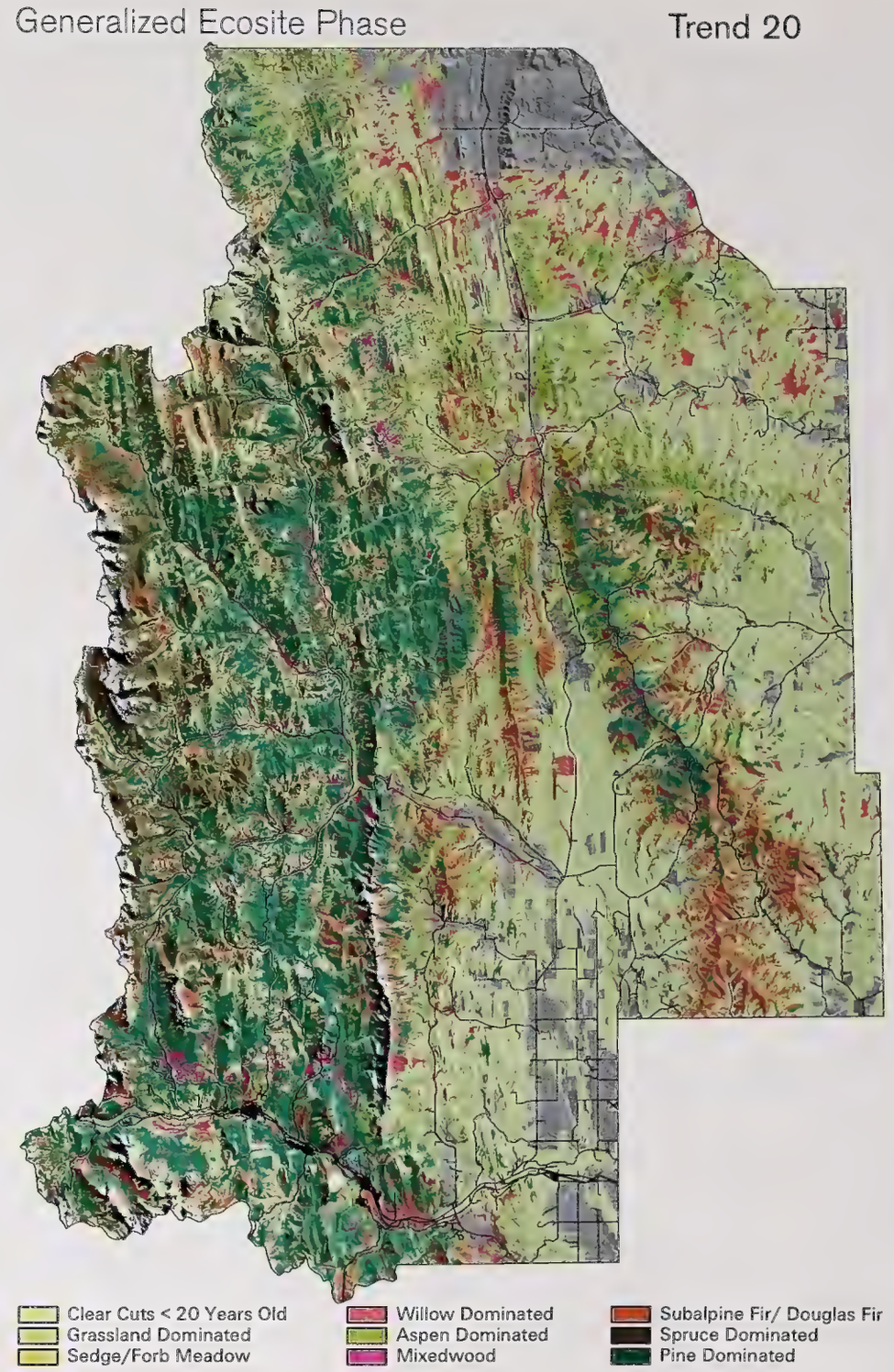
3.3. THE TREND SCENARIO

Forest resources are currently allotted to several companies in the area. The Trend Scenario is used to assess the likely future conditions, given current trends, if nothing is done to change existing regulations and everything that is currently legally permissible is logged. The alternative is based on following existing ground rules but does *not* reflect current cut or commitments. The alternative has been examined in order to demonstrate what could happen in the absence of a new direction and indicates the effects of maintaining the status quo. All existing commitments, regulations and plans will be followed. The following summarizes the assumptions of this alternative:

- an even flow of fibre for 200 years, with 50 years spatially sequenced
- no additional protected areas are established
- all currently legislated protected areas are respected and excluded from the land base (at the time of the analysis, the Whaleback was included in the net landbase)
- the net land base is determined by current Provincial Operating Ground Rules and other subjective deletions
- other deletions included East Slopes Policy Zones 1, 3, 6, 7, 8, 9, free hold land, slopes >45%, stream buffers, access buffers
- a minimum cutblock size of 1 ha
- regeneration lags are identified by ecosite
- percent regeneration failure are identified by ecosite
- 10 year green up constraint applied to all existing cutblocks
- succession was dealt with through yield curve transitions
- no partial cuts – all harvesting is clearcuts
- regeneration emphasis is on lodgepole pine
- regeneration lags applied by ecosite
- adjacency constraints by ecosite
- current silvicultural methods and levels of success will continue
- unmanaged stand yield tables will be used
- minimum harvest age of 80 years
- cutblock sizes will be restricted by the following:
  - pine and deciduous cutblock sizes will not exceed 100 ha but will average no more than 60 ha
  - spruce cutblock sizes will not exceed 24 ha
- no restrictions on the distribution of the blocks throughout the study area aside from staying within the net land base area
- adjacent stands are eligible for harvest when previously harvested cutblocks are reforested to the standards given in the Timber Management Regulations and when the following height requirements are met:
  - coniferous cutblocks: regeneration has reached 3 m where a two–pass harvest is planned
  - deciduous cutblocks: regeneration has reached 3 m in height and 10 years have passed since the previous harvest pass
- stream protection buffers shall be retained along watercourses as prescribed in the ground rules. Harvesting will not be permitted within 60 meters of large permanent streams and 30 meters from small permanent streams.
- no harvesting restrictions will apply to intermittent or ephemeral streams other than as noted in the ground rules for debris disposal and equipment operation. Harvesting of merchantable timber will occur in these zones.
- recreational use on random sites will continue
- oil and gas exploration and extraction will continue
- all access roads installed for forestry or other industrial activities will remain open to the public and will never be removed
- only block skid trails and roads will be reclaimed (these will be revegetated but not recontoured)
- existing grazing commitments will be honoured
- there are no losses to fire or insect and disease

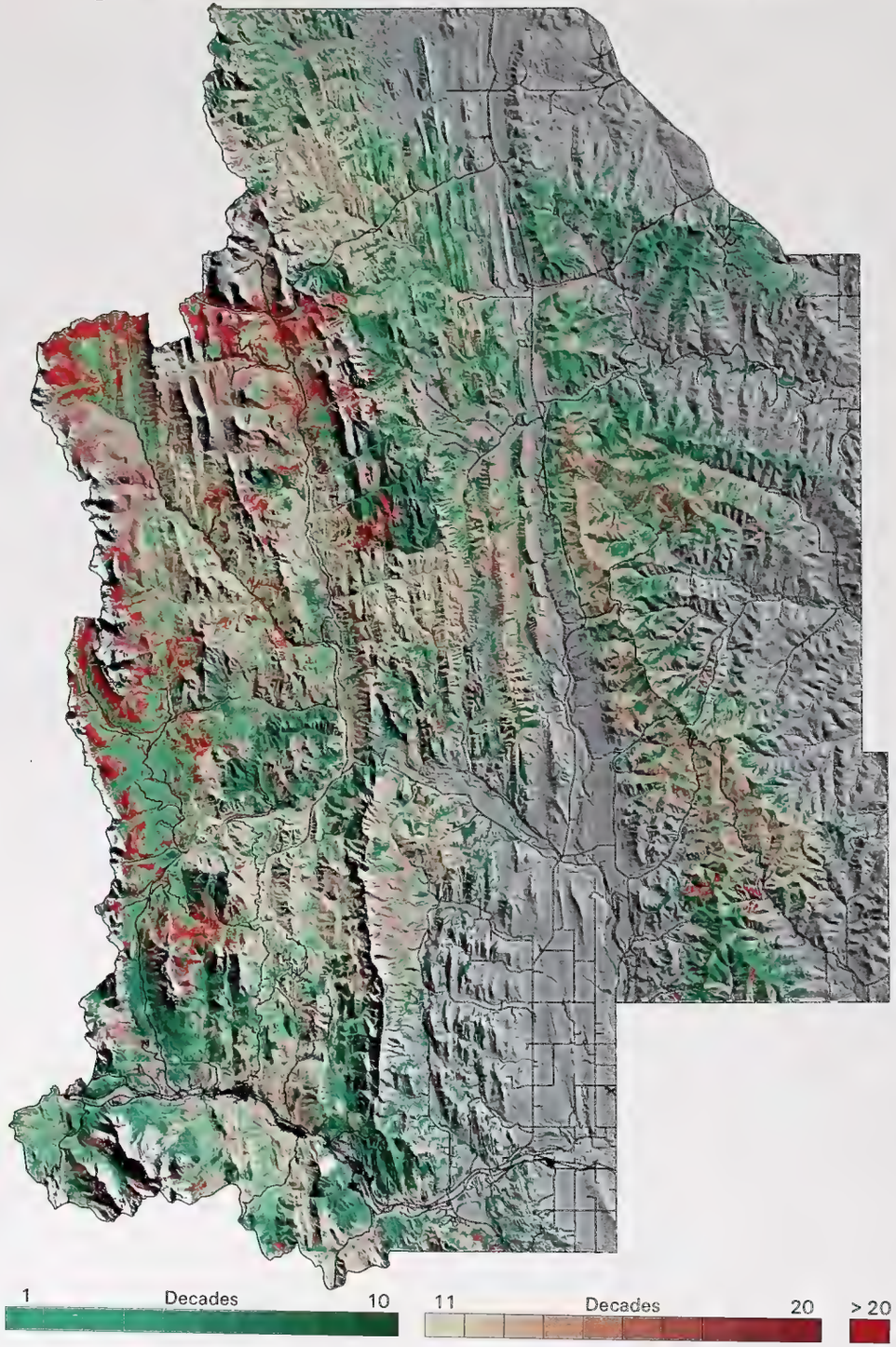
Figure 15. Ecosite Phase by Leading Component – Trend 20





Age Class

Trend 20



Cutblocks and Access

Trend 20

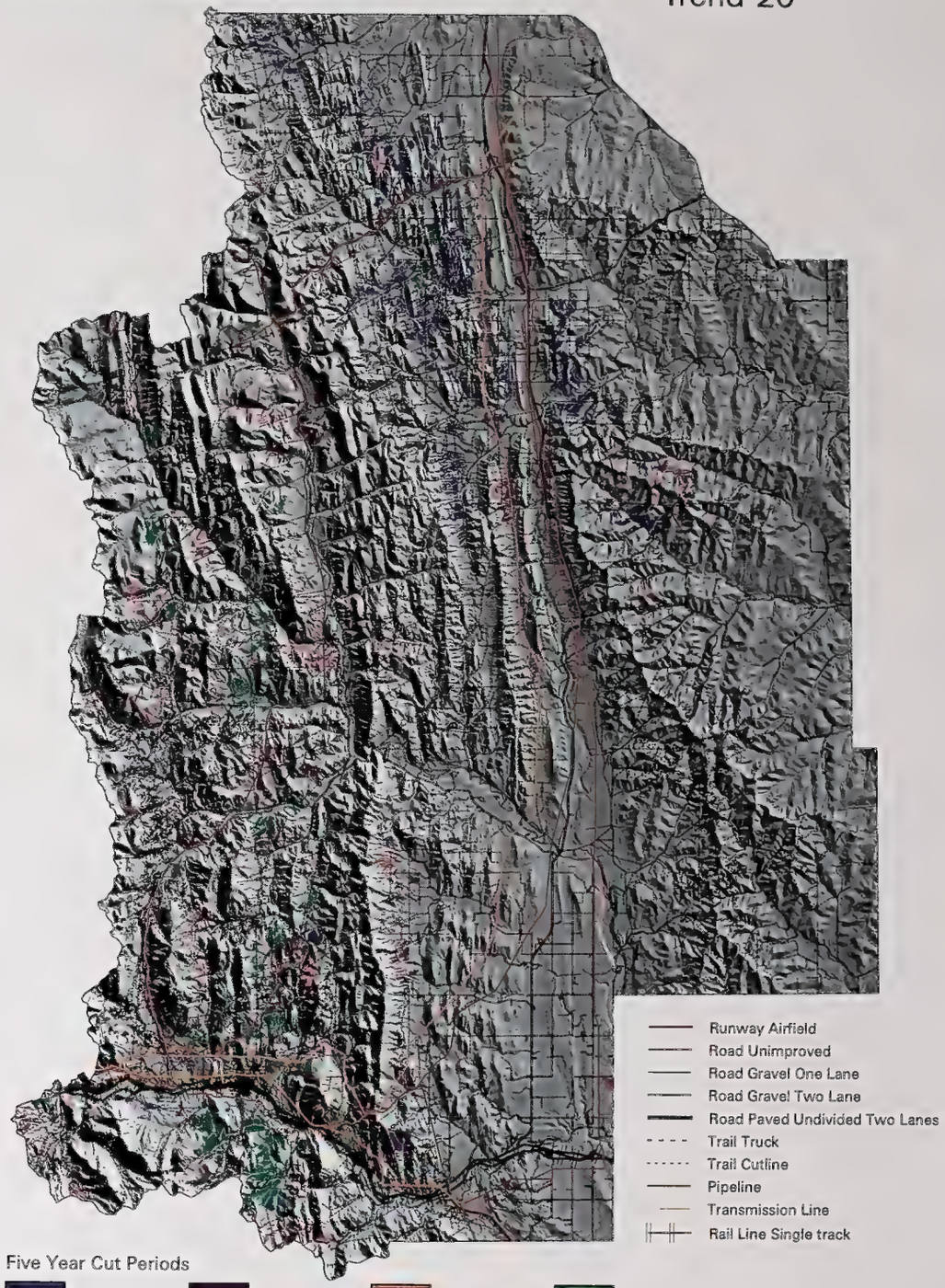


Figure 16. Coniferous, Deciduous, Mixedwood, Grassland, Other Patch Size – Trend 20

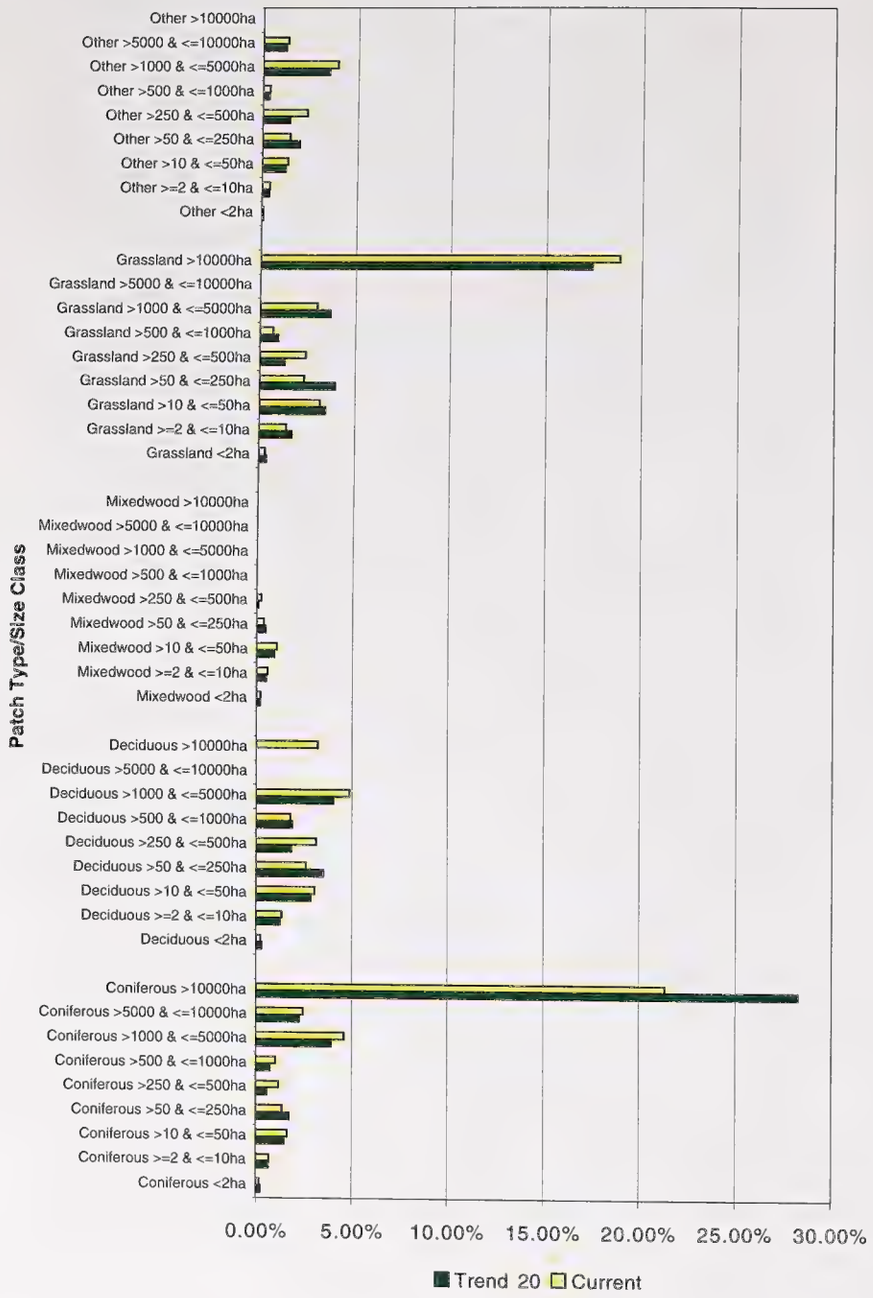


Figure 17. Regional Age Class Distribution – Trend 20

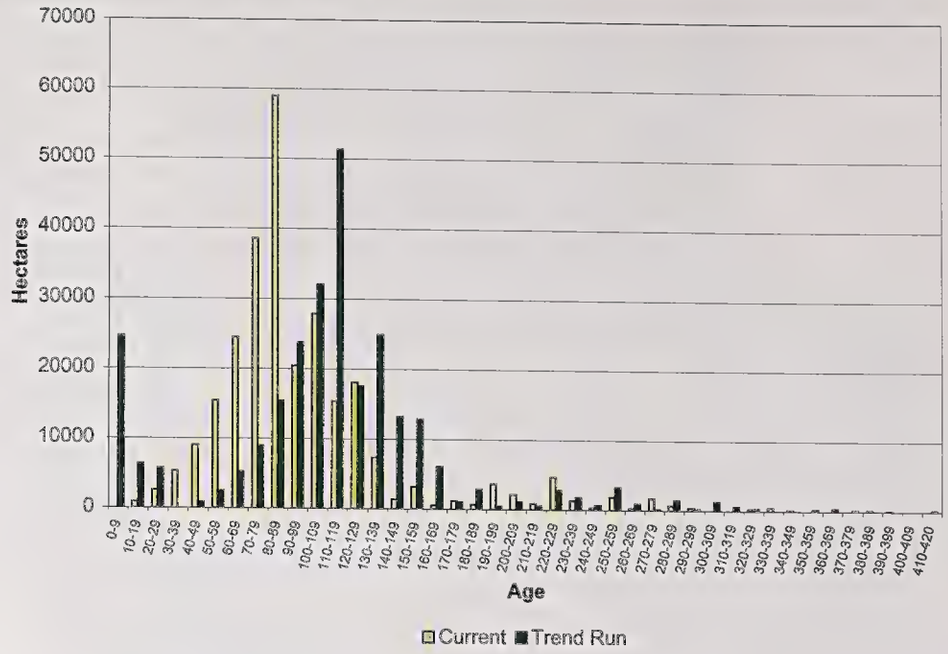


Figure 18. Disturbance Patch Size – Trend 20

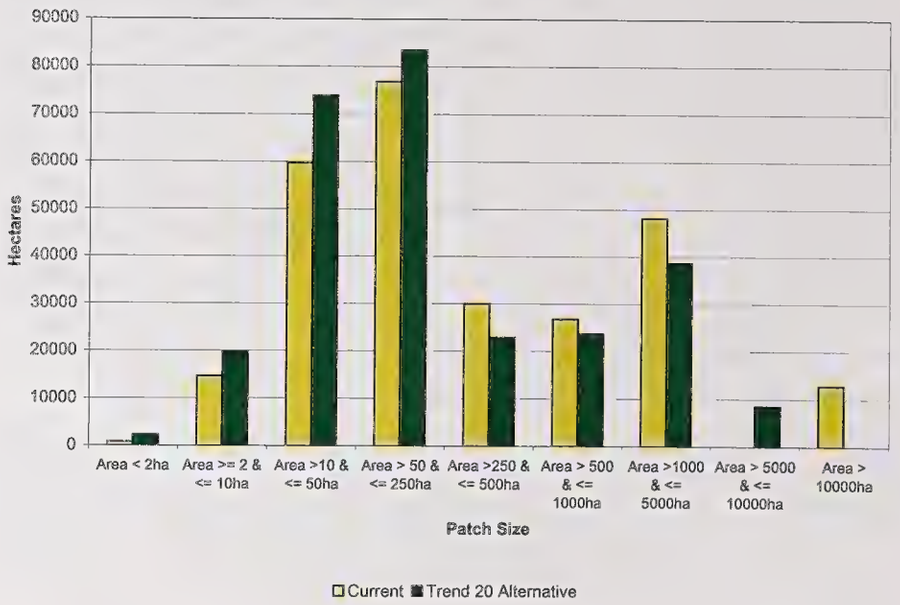


Figure 19. Visualization – West of Livingston Range – Trend 20

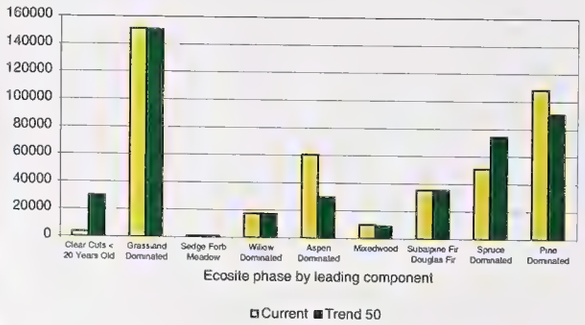
The Trend Scenario
Trend 50

The Trend Scenario has been projected for 50 years into the future. Harvesting is highly dispersed and occurs in all landscape management units. The result is a fragmented and very accessible region with roads in all major valleys. Several ecosite phases have been lost in this alternative chiefly through conversion to lodgepole pine. Clearcuts less than 20 years old have also increased. Aspen stands have been considerably reduced, largely through succession. Mixedwood is slightly reduced. Many spruce ecosite phases have been replaced with pine through regeneration methods that favour that species. However, as much of the landbase is not harvested, spruce actually increases.

Age class distribution shows considerable change from the present in two broad areas. A greater percentage of the study area is in the categories between 130 – 170 years old. Older growth generally decreases in age with some old growth cohorts disappearing. At the same time, there are far greater amounts in the younger age classes. These changes are due, in part, to preference given to cutting the oldest first in current operating rules as well as the result of 50 years of regeneration of a considerable amount of harvested areas. The area of the land base that is in older age classes can be expected to increase (in the absence of fire or increased harvesting) as the large areas that have been excluded from harvesting are simply getting older. While the effect on age class is pronounced, it is not as extreme as in some other scenarios.

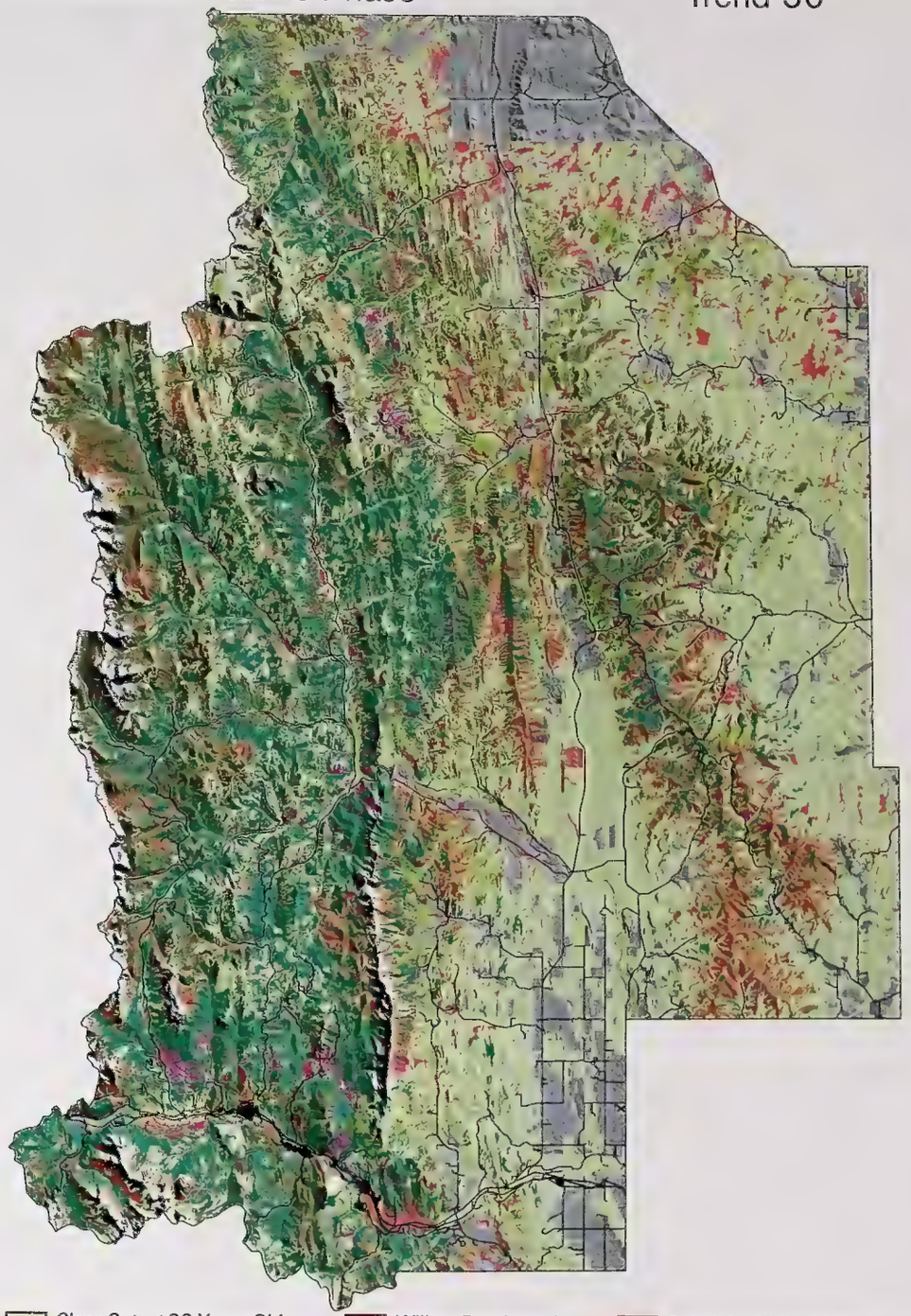
As current operating rules specify harvest patches much smaller than the inherent disturbance regime, the disturbance patch size distribution is moving towards smaller patches.

Figure 20. Ecosite Phase by Leading Component – Trend 50



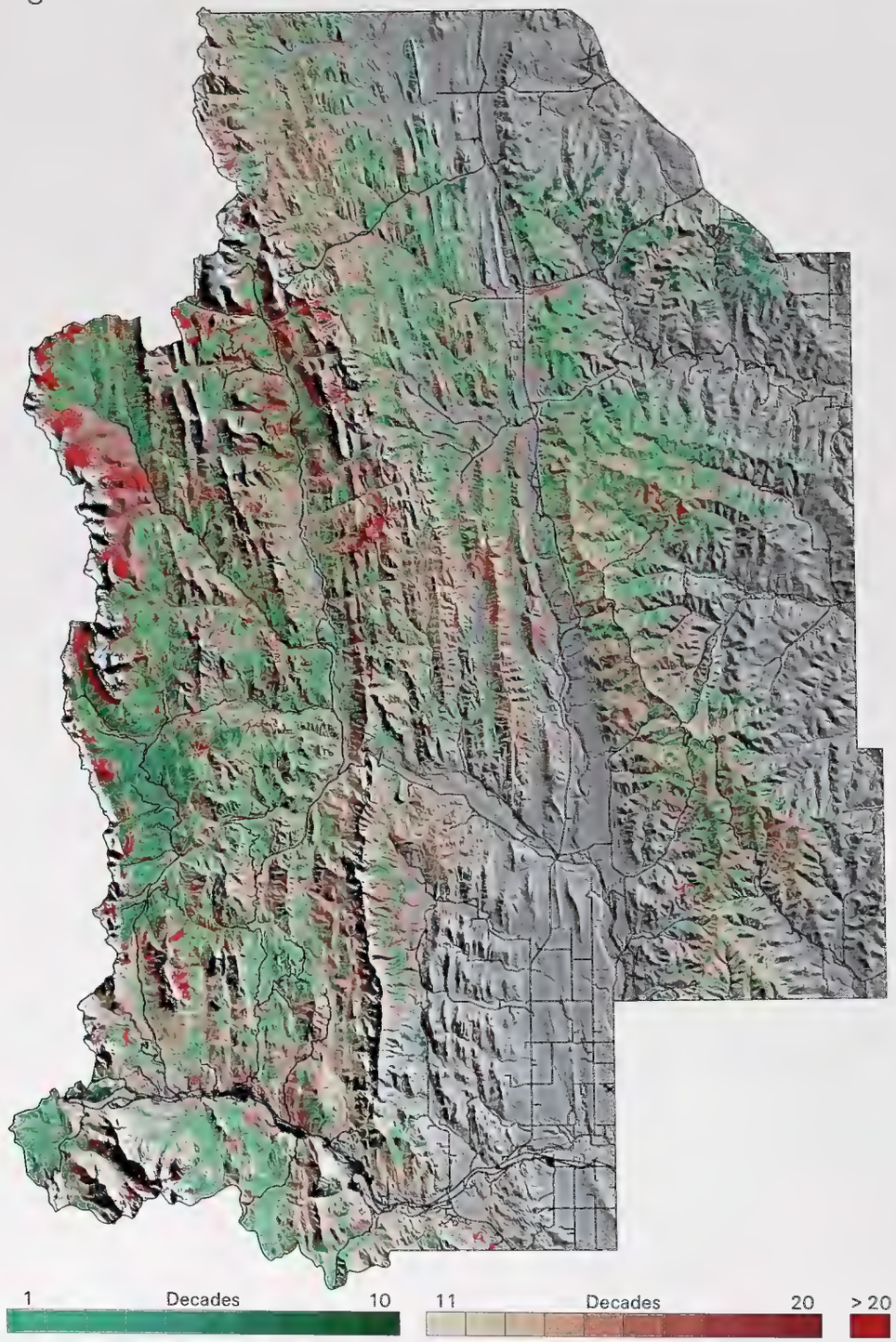
Generalized Ecosite Phase

Trend 50



Age Class

Trend 50



Cutblocks and Access

Trend 50

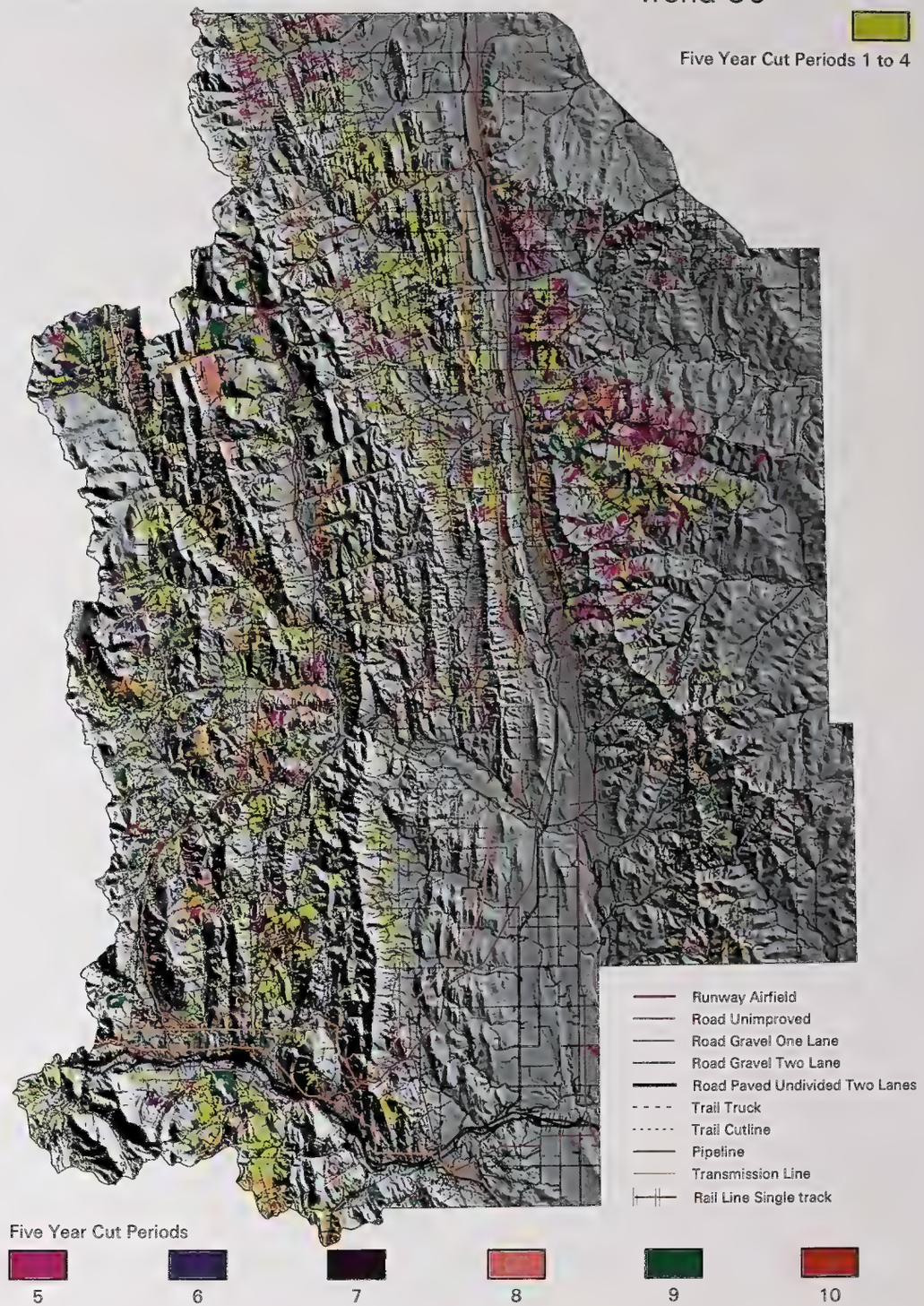


Figure 21. Coniferous, Deciduous, Mixedwood, Grassland, Other Patch Size – Trend 50

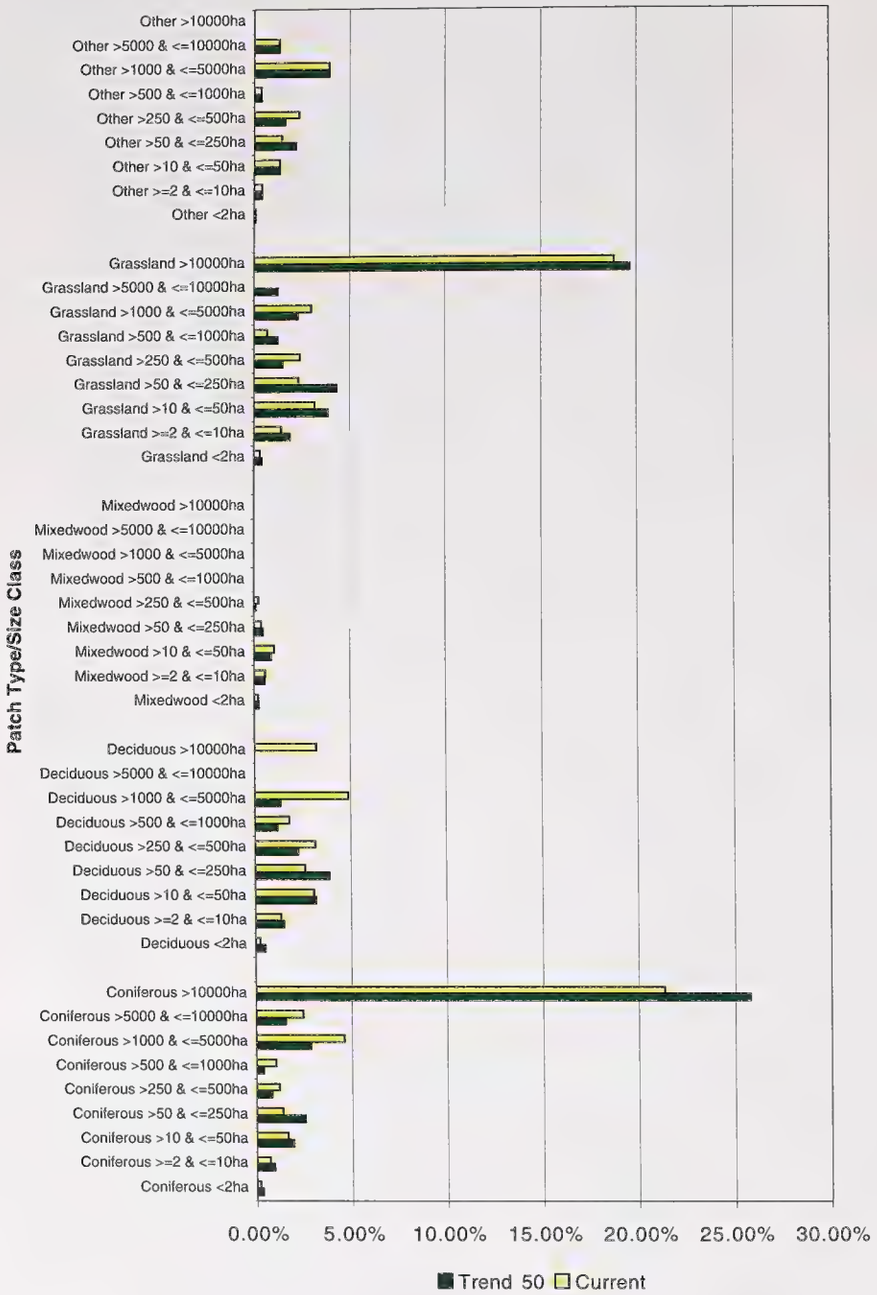


Figure 22. Regional Age Class Distribution – Trend 50

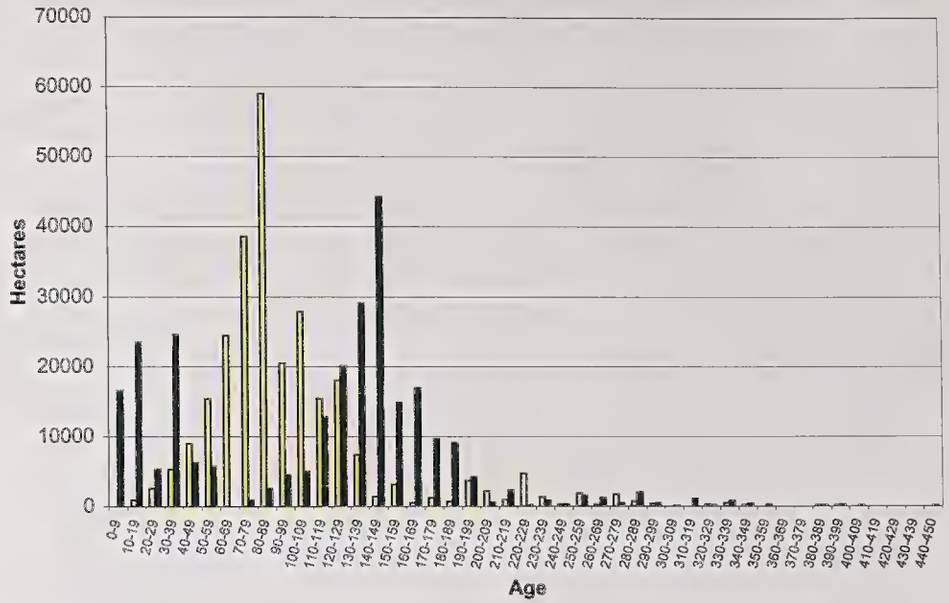


Figure 23. Disturbance Patch Size – Trend 50

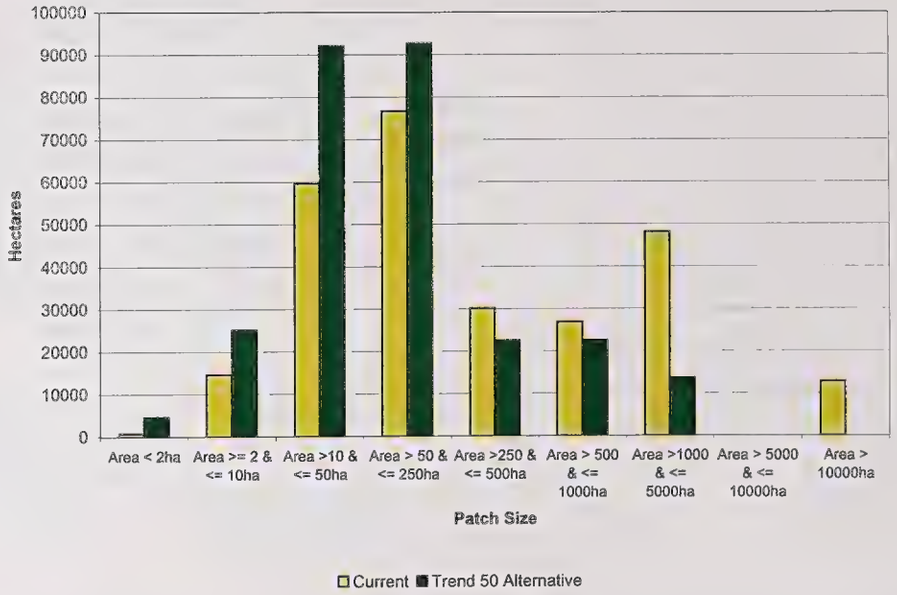
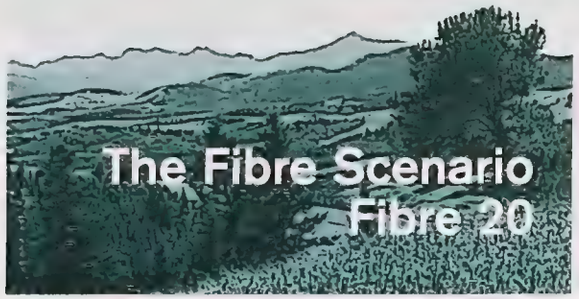


Figure 24. Visualization – West of Livingston Range – Trend 50

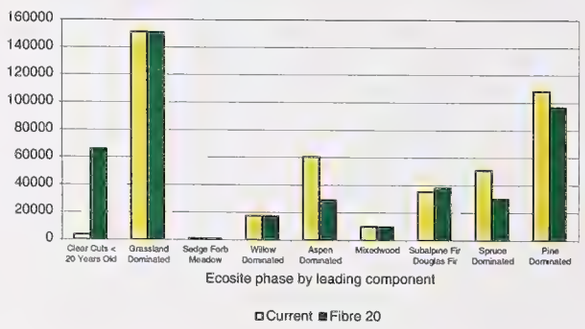


3.4. THE FIBRE SCENARIO

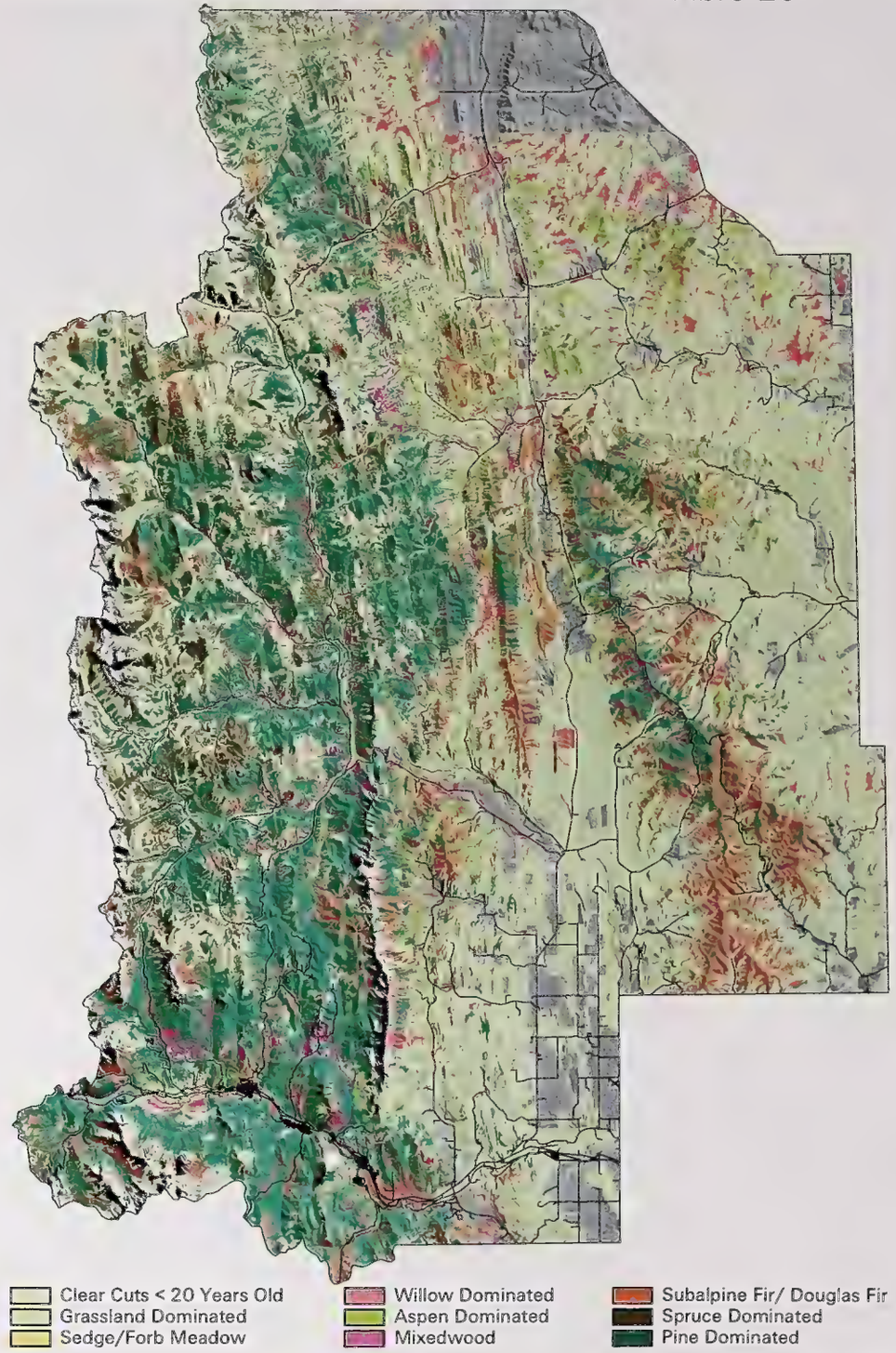
The Fibre Scenario explores the possible future conditions should current planning be overwhelmed by economic pressures and the area managed for the maximization of wood fibre production with little regard for other forest values or existing ground rules. Under this scenario, there is little or no regard for many other aspects of forest land use, ecological integrity or scenic quality. The full productive land base without net down, other than currently protected areas and inoperable locations, will be utilized in this alternative. The examination of this unlikely and exaggerated scenario will aid in the identification of major areas of conflict and coincidence with other uses. It will also indicate where more intensive operations do not present conflict. The following are the assumptions of this alternative:

- the full productive land base without net down other than inoperable areas (i.e. slopes over 65%, wetlands, etc.) is utilized
- everything merchantable is harvested
- no stream buffers
- Crown lands in the White Zone were harvested
- currently legislated protected areas are not harvested (the Whaleback was not protected at the time of modelling and was harvested)
- opening size is maximized for harvesting efficiency and silvicultural considerations
  - no maximum cutblock size
  - minimum cutblock size = 1 ha
- pine plantings and stand conversions are maximized
  - spruce, subalpine and Douglas fir converted to pine when regenerated
- intensive forest management including fertilizing, herbicides, improved tree genetics and commercial thinning is employed
- all roads will be left in place with complete public access
- no adjacency rules were applied
- oil, gas and coal exploration and extraction operations continue to expand
- grazing concerns are largely ignored in harvest planning (grazing does continue however)
- enhanced forest management is carried out on mesic and rich ecosites within the forest reserve
- no regeneration lags
- no regeneration failure
- no adjacency constraints
- no grassland conversion to forest

Figure 25. Ecosite Phase by Leading Component – Fibre 20

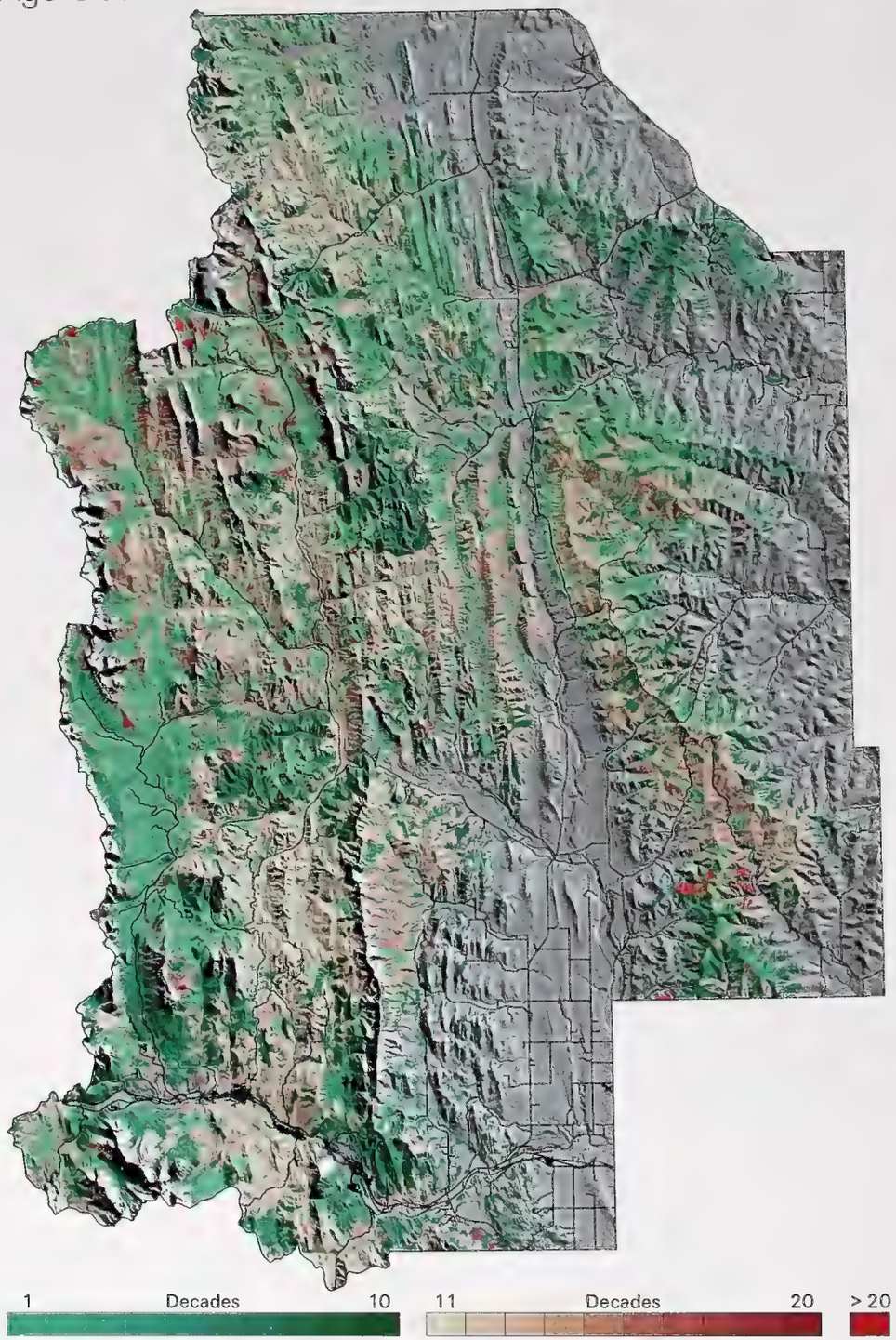


Generalized Ecosite Phase — Fibre 20



Age Class

Fibre 20



Cutblocks and Access

Fibre 20

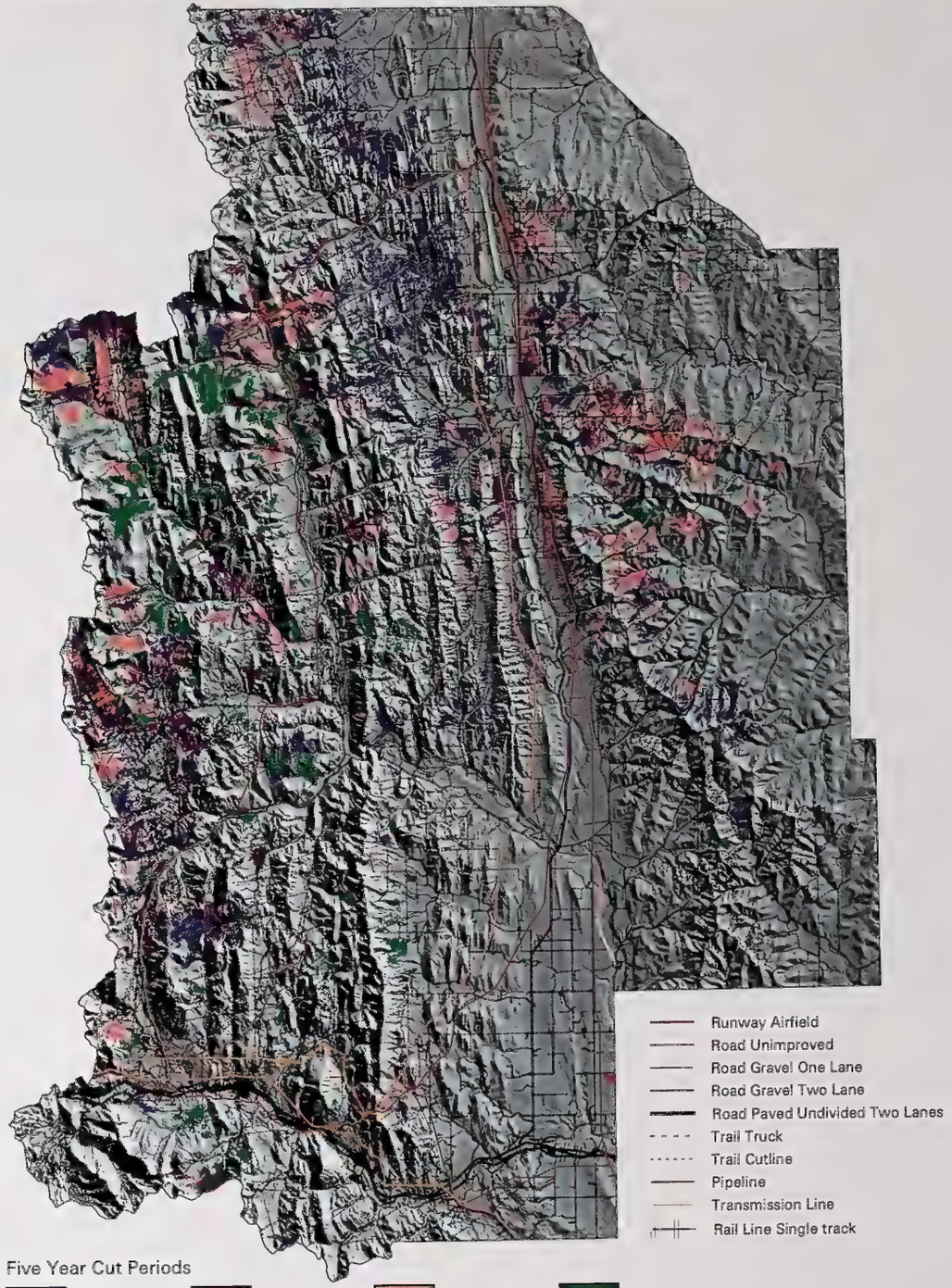


Figure 26. Coniferous, Deciduous, Mixedwood, Grassland, Other Patch Size – Fibre 20

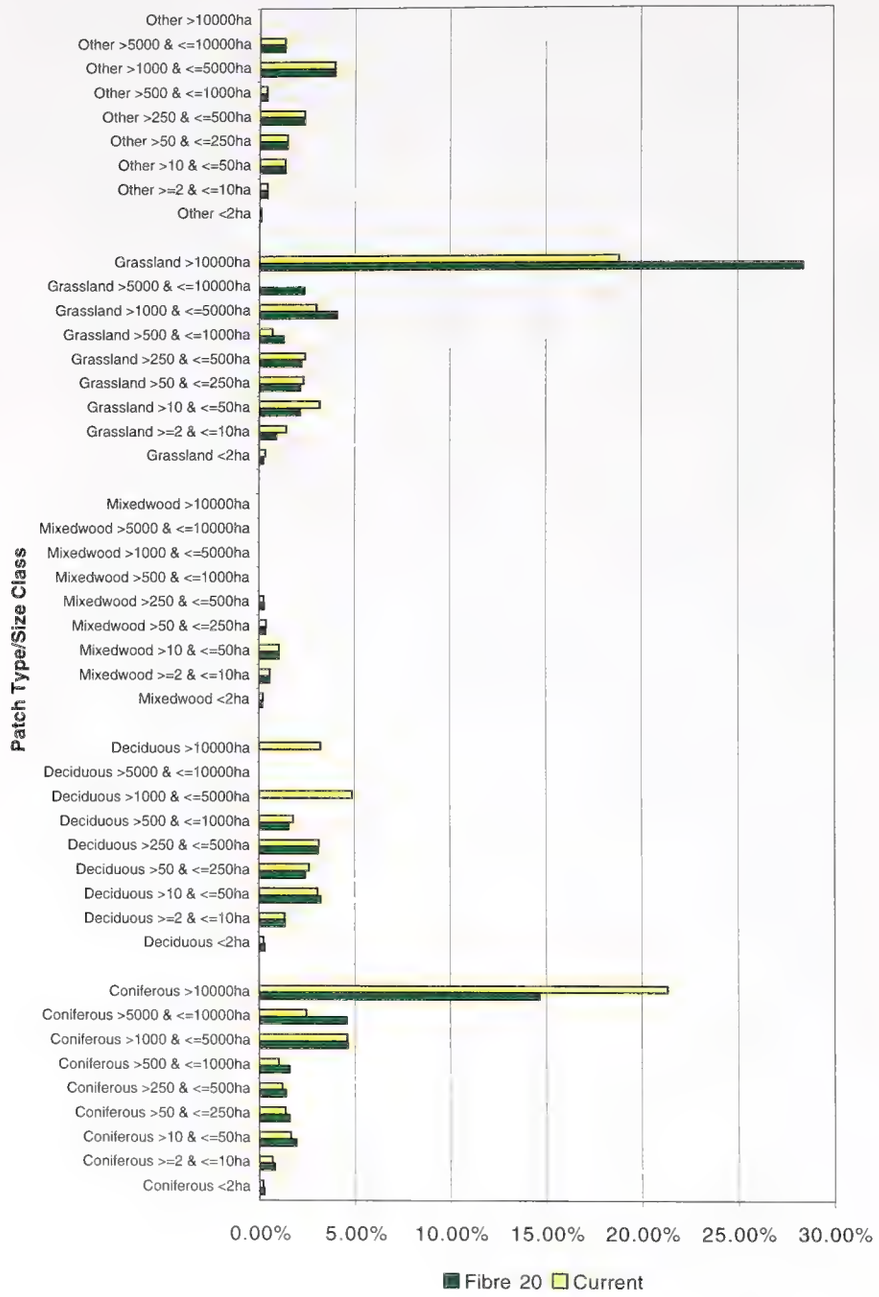


Figure 27. Regional Age Class Distribution – Fibre 20

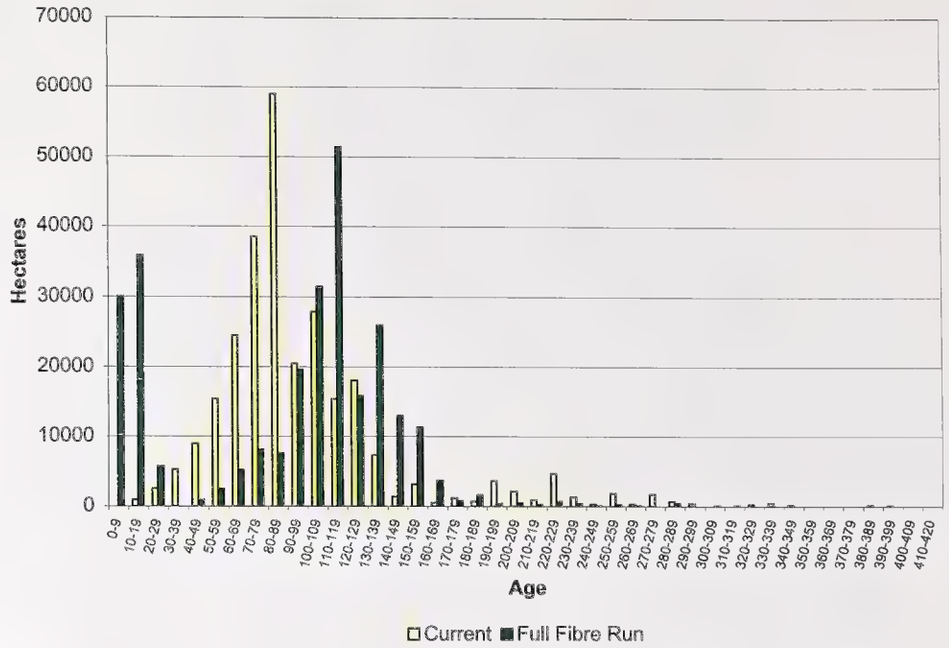


Figure 28. Disturbance Patch Size – Fibre 20

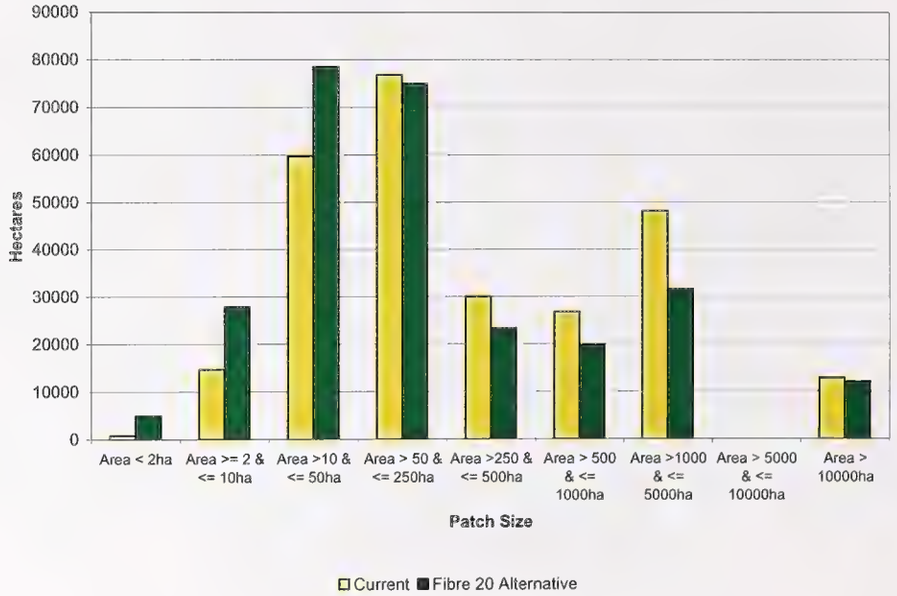
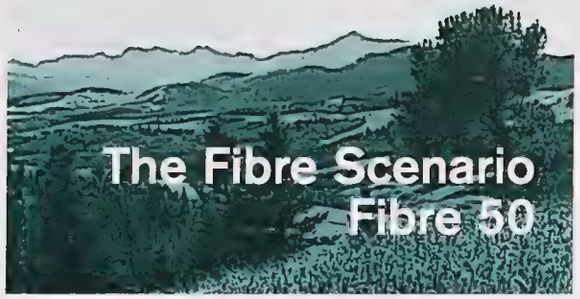


Figure 29. Visualization – West of Livingston Range – Fibre 20



The Fibre Scenario
Fibre 50

The Fibre Scenario explores the possible future conditions if harvesting in the area is based on maximizing wood fibre production with little or no regard for other values or current operating ground rules. It has noticeable effects on both species distribution and age class representation. As in the Trend Scenario, aspen is greatly decreased, chiefly through succession, while mixedwood is slightly reduced. Spruce increases while it appears as though pine is decreasing. This is not actually the case as the cutblocks less than 20 years old are greatly increasing and, under this scenario, are almost exclusively regenerated to pine. The increase in spruce is likely due to species succession on inoperable areas. Harvesting is highly dispersed and occurs in all landscape management units. As in the Trend, the harvesting and required roading results in a fragmented and very accessible region with roads in all major valleys.

Age class distribution shows considerable change from the present. A greater percentage of the study area is in the categories between 130 – 170 years old. Older growth generally decreases with some old growth cohorts disappearing. At the same time, there are far greater amounts in the youngest age classes.

Patch size is changing and the overall "grain" of the landscape is moving away from what would be found under a more natural disturbance regime. Most of the cutting is in patches between 10 and 50 ha. A greater amount of edge and a reduction in patch interiors will result.

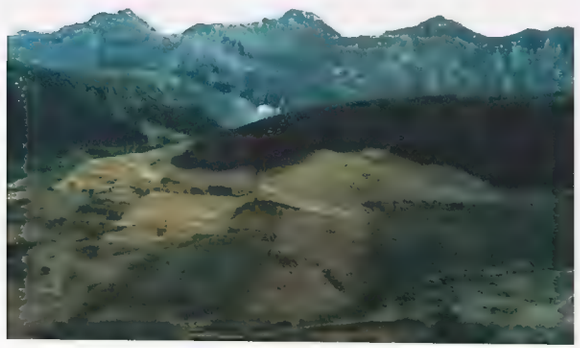
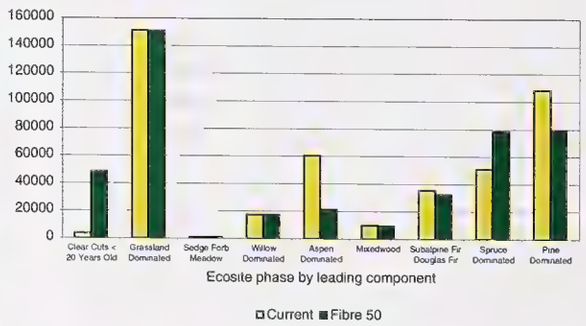
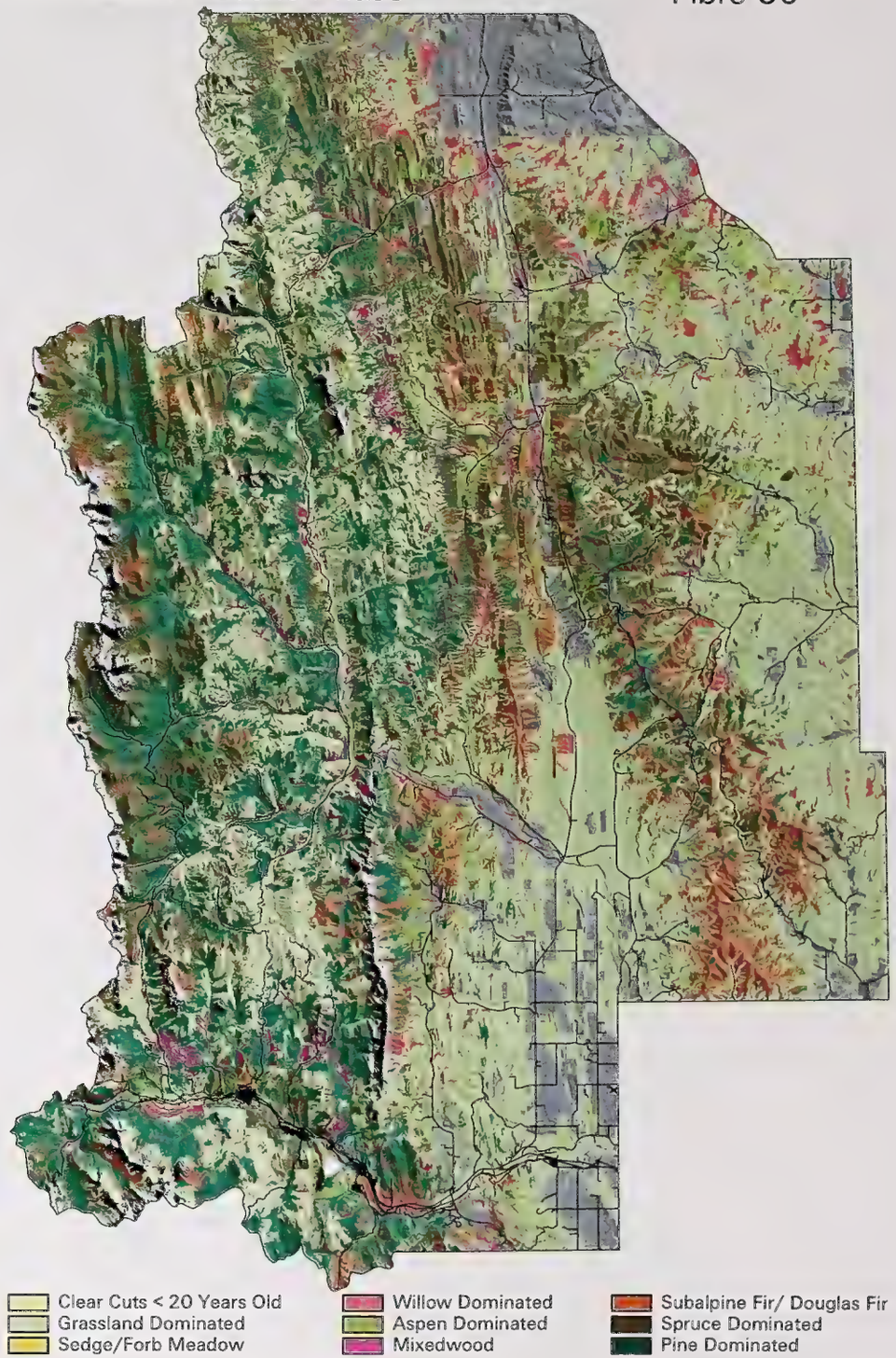


Figure 30. Ecosite Phase by Leading Component – Fibre 50



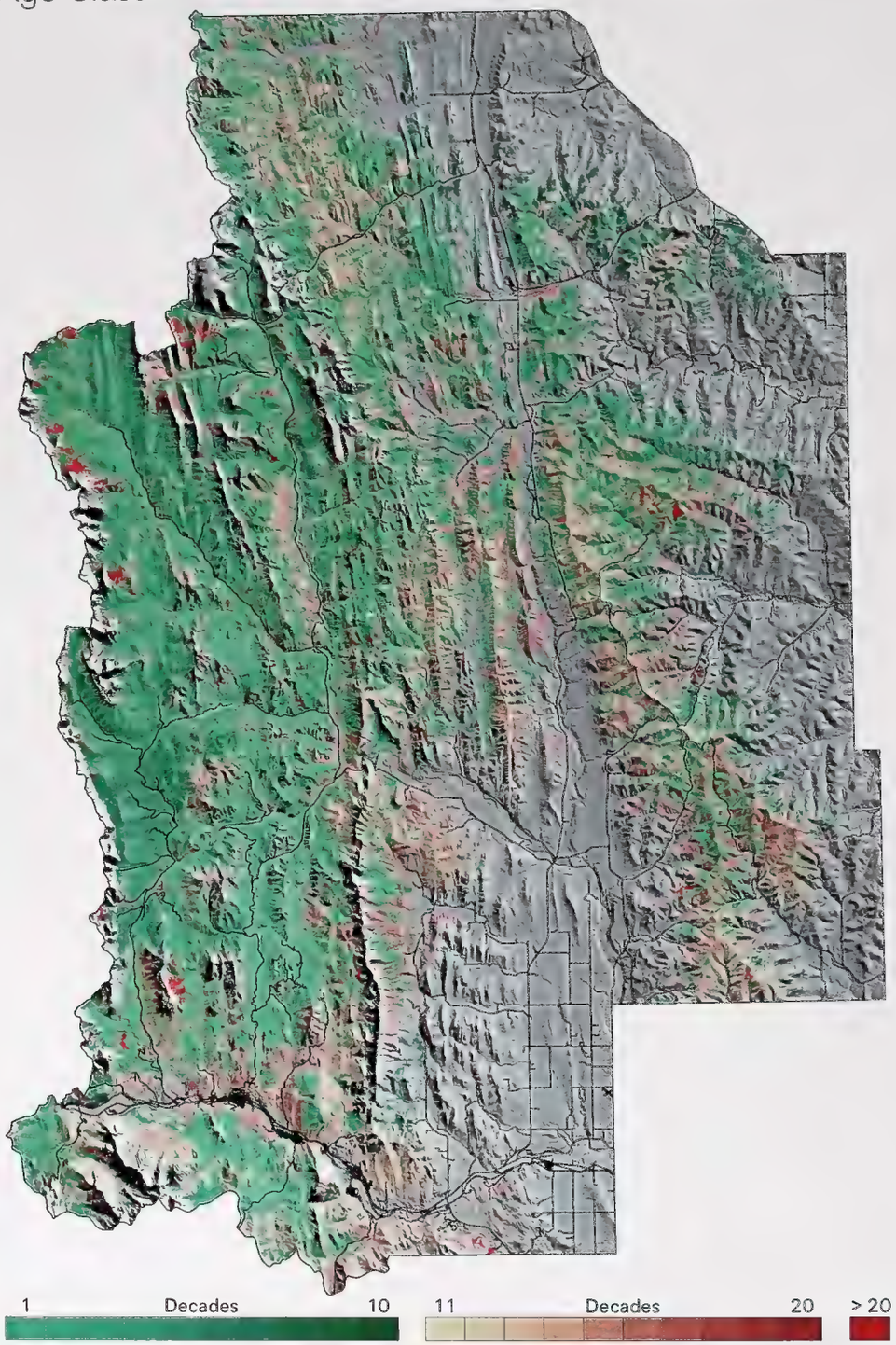
Generalized Ecosite Phase

Fibre 50



Age Class

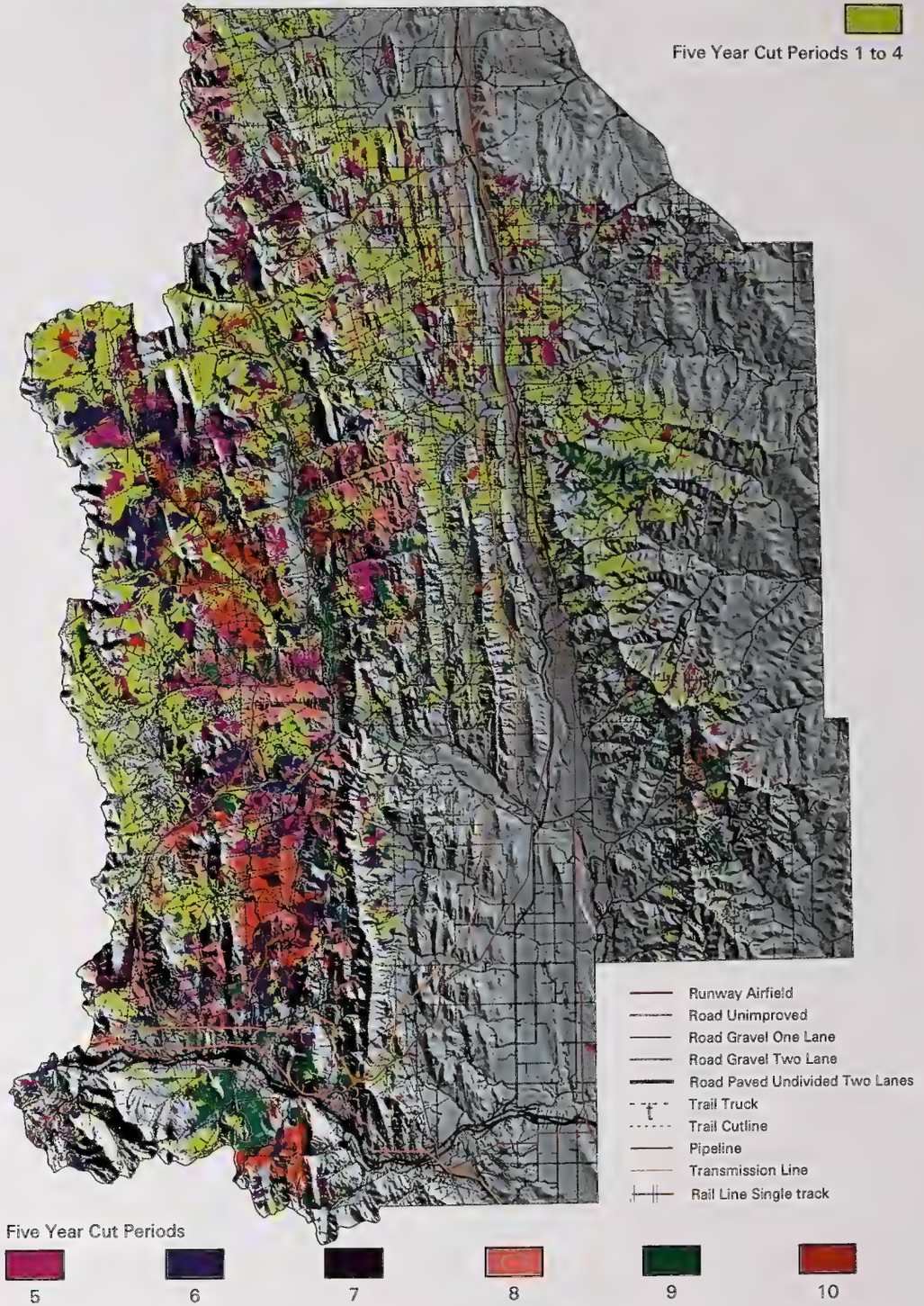
Fibre 50



1 Decades 10 | 11 Decades 20 | > 20

Cutblocks and Access

Fibre 50



Five Year Cut Periods 1 to 4

Runway Airfield
Road Unimproved
Road Gravel One Lane
Road Gravel Two Lane
Road Paved Undivided Two Lanes
Trail Truck
Trail Cutline
Pipeline
Transmission Line
Rail Line Single track

Five Year Cut Periods

5 6 7 8 9 10

Figure 31. Coniferous, Deciduous, Mixedwood, Grassland, Other Patch Size – Fibre 50

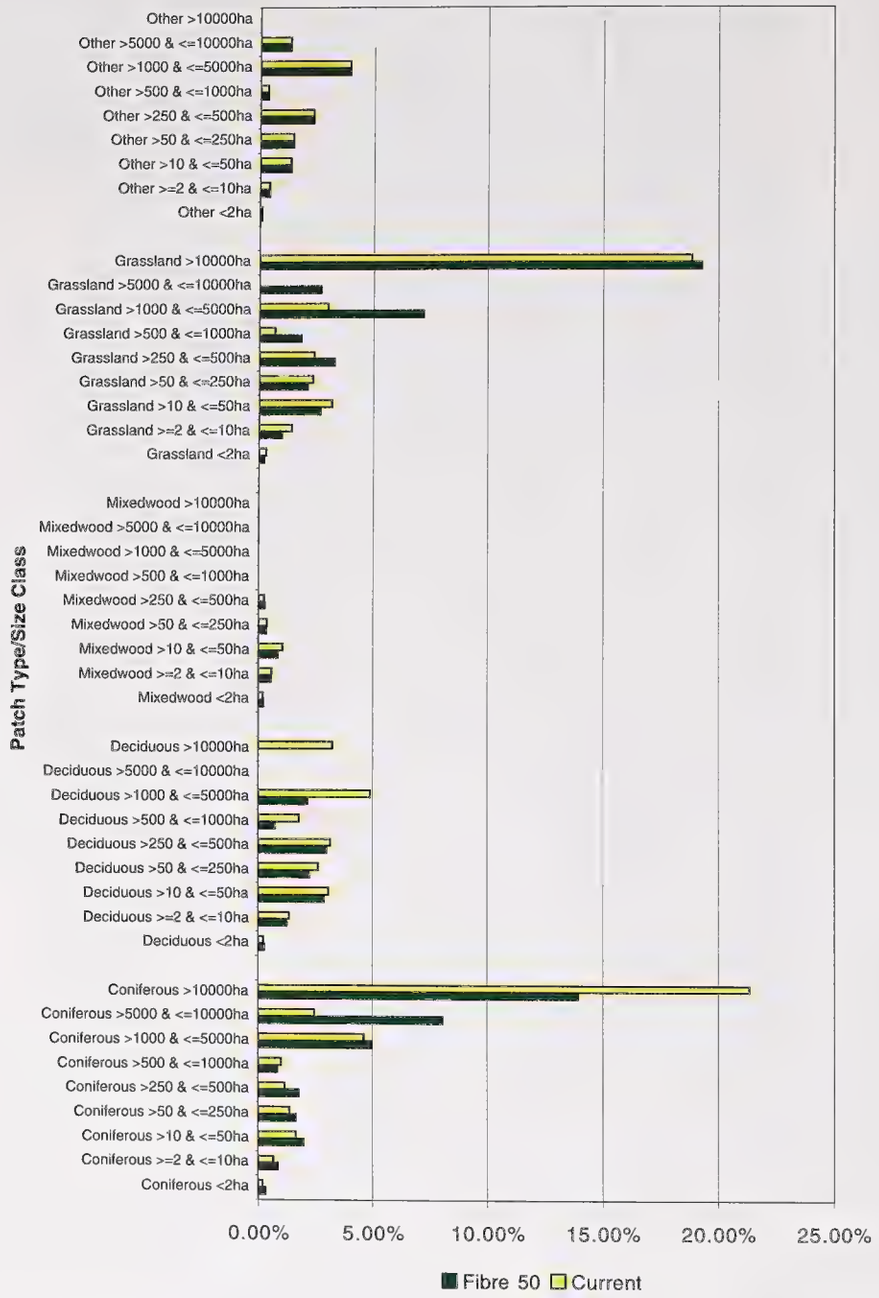


Figure 32. Regional Age Class Distribution – Fibre 50

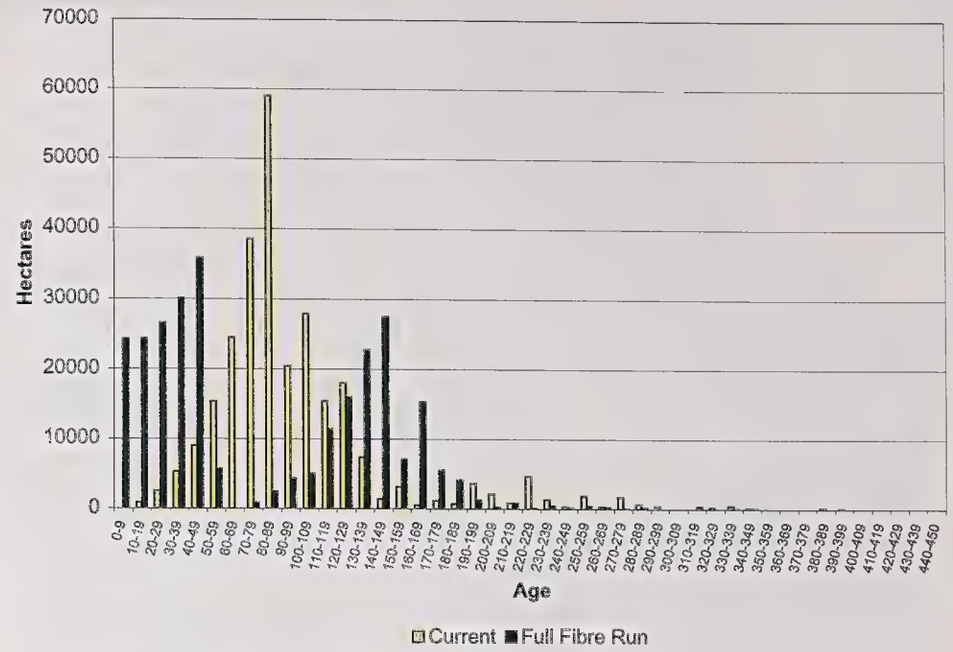


Figure 33. Disturbance Patch Size – Fibre 50

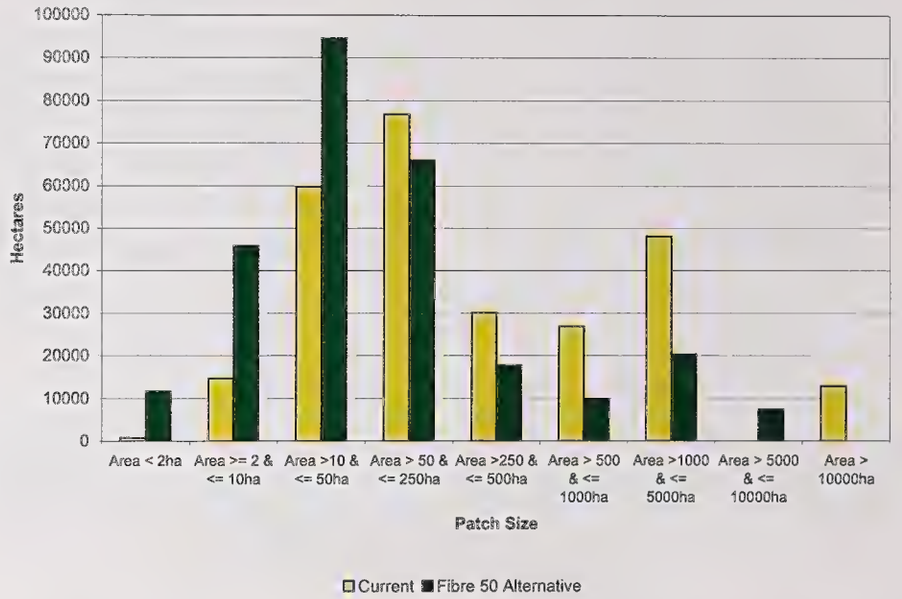


Figure 34. Visualization – West of Livingston Range – Fibre 50

The Preservation Scenario Preservation 20

3.5. THE PRESERVATION SCENARIO (PRESCRIBED BURN MANAGEMENT)

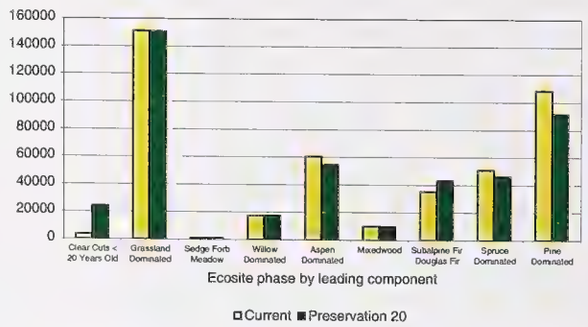
Under this alternative, fibre production and industrial activity is entirely eliminated. The area is managed for preservation as a quasi wilderness area and is managed for conservation of ecological resources and scenic quality. Recreational use is limited to backcountry use on existing trails. Vehicular access is limited to the existing main roads. All other minor access roads and truck trails are eliminated. Among others, the following indispensable patterns (Forman, 1995) are maintained:

- maintenance of large contiguous patches of natural vegetation
- wide vegetation corridors along major water courses
- connectivity for key species among the large patches

Forest management and maintenance of vegetation diversity is accomplished predominantly with prescribed fire. This alternative is developed in order to identify the economic tradeoffs of exclusion of industrial activities as well as the potential costs of fire management. The following are the assumptions of the alternative:

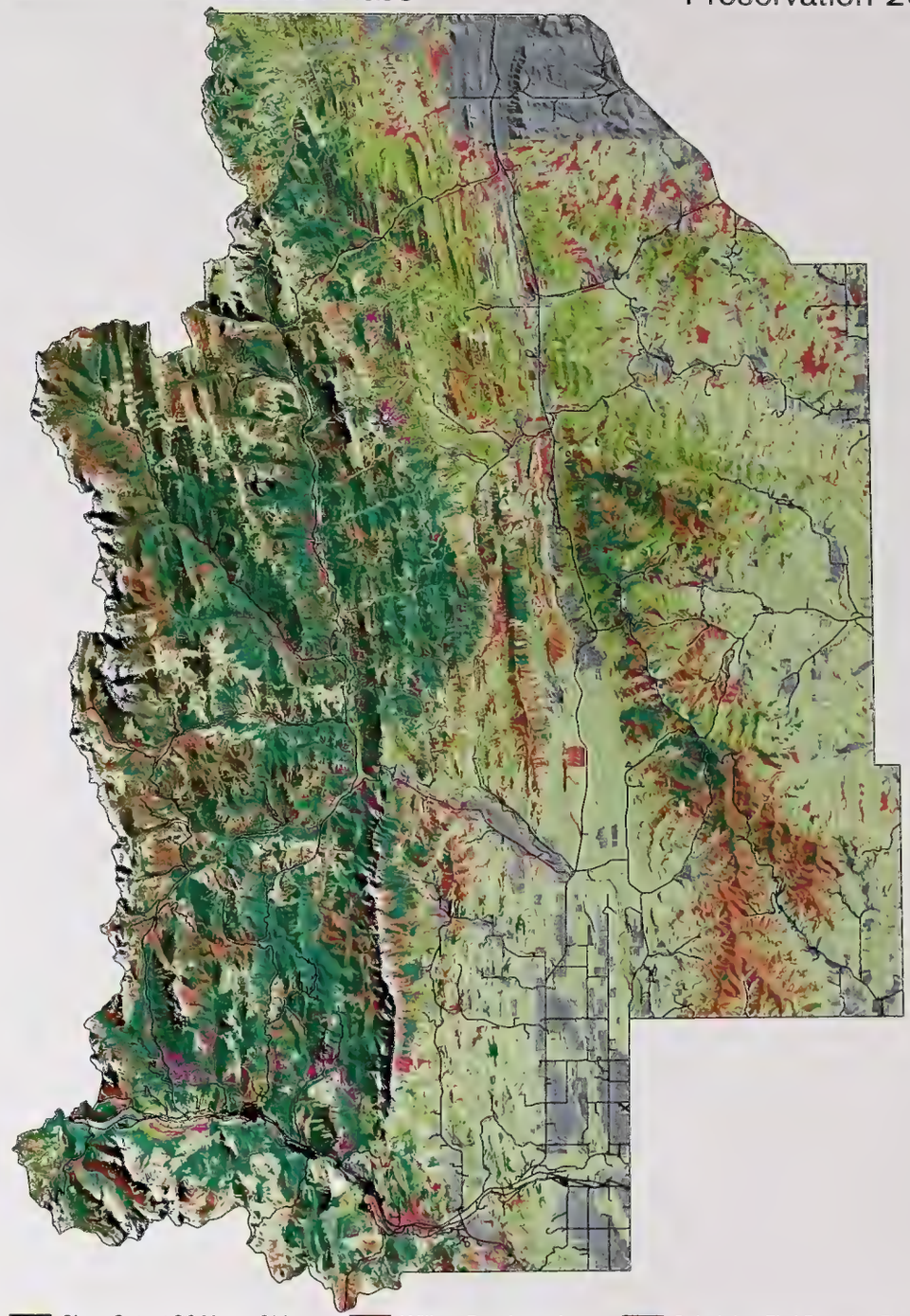
- fire control and prescription burning are used to maintain current age class and vegetative (ecosite phase) distribution
- industrial operations (forestry, energy and mining) are entirely eliminated from the forest reserve portions of the study area
- grazing is retained on public lands, including the Whaleback and other heritage rangelands
- access is controlled similar to the rules of Willmore Wilderness
- the forestry trunk road is retained but all other roads in the Forest Reserve are reclaimed to trail status
- seasonal closures of the forestry trunk road will be considered
- staging areas for backcountry use are provided — if the forestry trunk road is totally closed, the staging areas would be at the north and south boundaries as well as at the Livingstone Gap.
- no vehicular random camping is allowed
- limited backcountry camping is allowed
- outfitter camps are designated
- limited backcountry trails are designated
- other rules of Willmore Wilderness Area are applied regarding permitted land uses
- unique, rare and special areas will be protected and managed (i.e. buffered 100 m)
- wet ecosites placed on a longer burn rotation (200 years)
- only lands within the green zone (including protected areas) are prescribed burned
- grasslands are also burned within the forest reserve
- no slope limitation on burning areas
- maximum burn size = 500 ha imposed
- no minimum burn size
- there are no adjacency or greenup constraints for identification of burn sites
- the 1950 Age Class distribution maintained by LMU was the target, although only approximated in the modelling

Figure 35. Ecosite Phase by Leading Component – Preservation 20



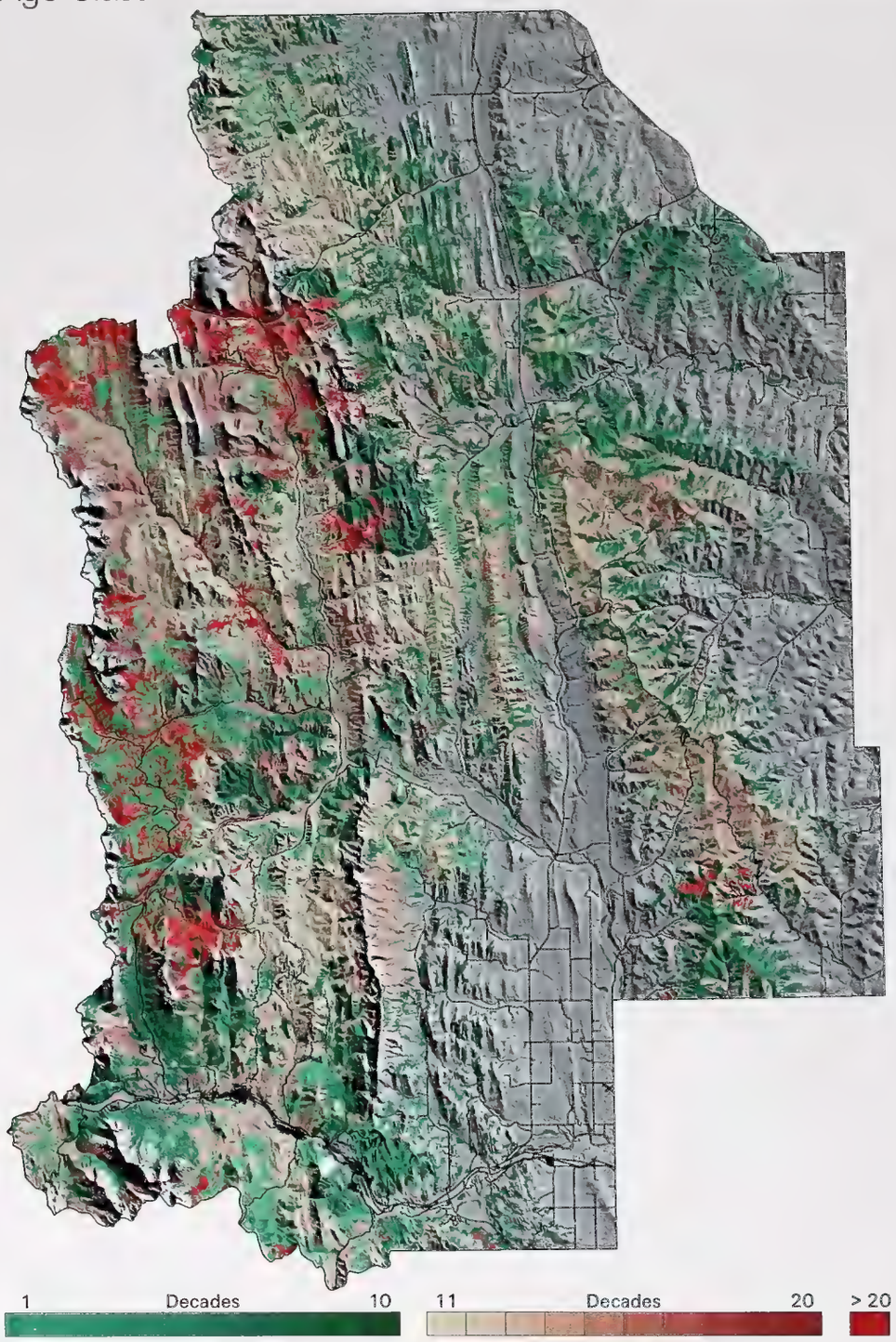
Generalized Ecosite Phase

Preservation 20



Age Class

Preservation 20



Prescribed Burns and Access

Preservation 20

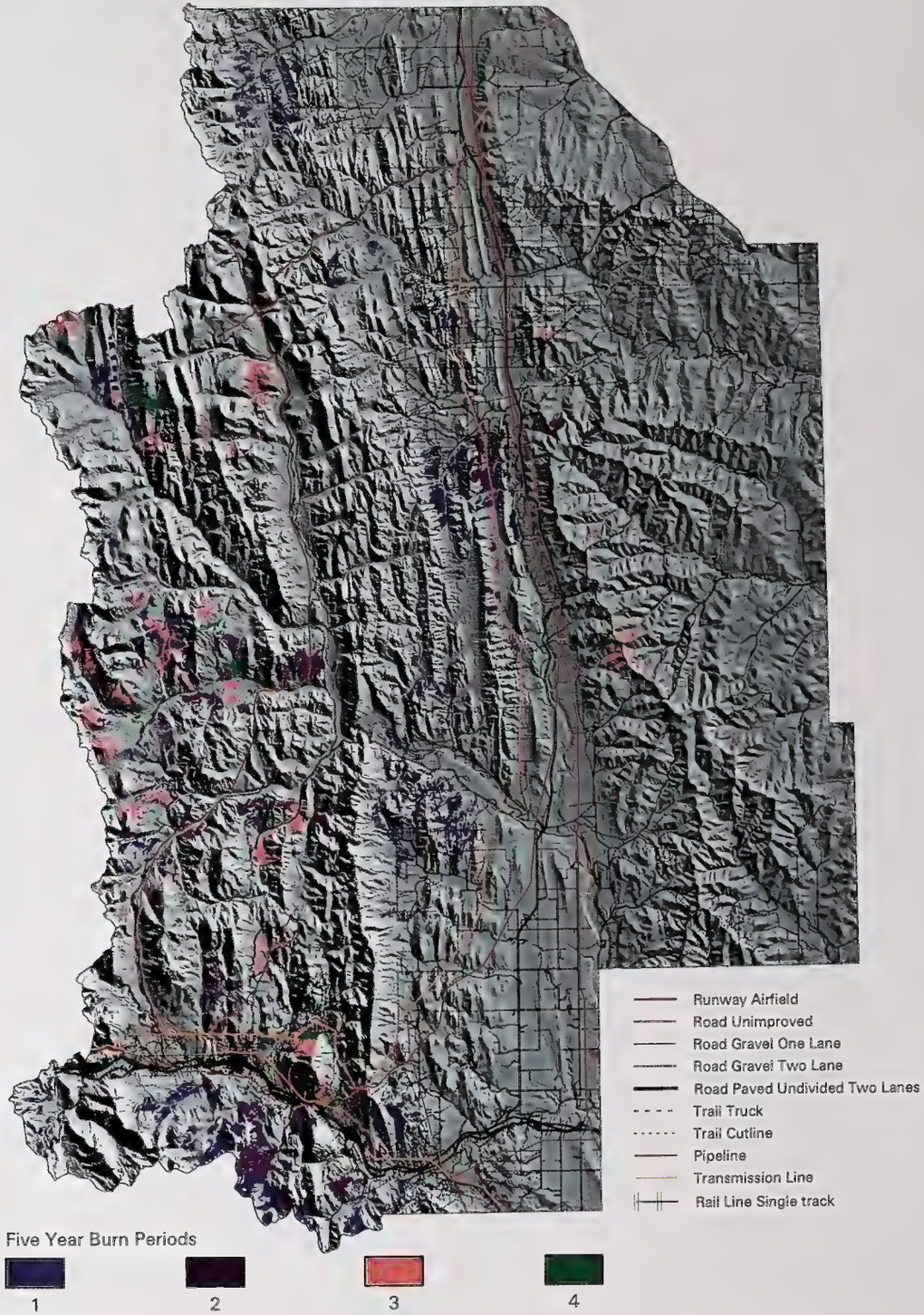


Figure 36. Coniferous, Deciduous, Mixedwood, Grassland, Other Patch Size – Preservation 20

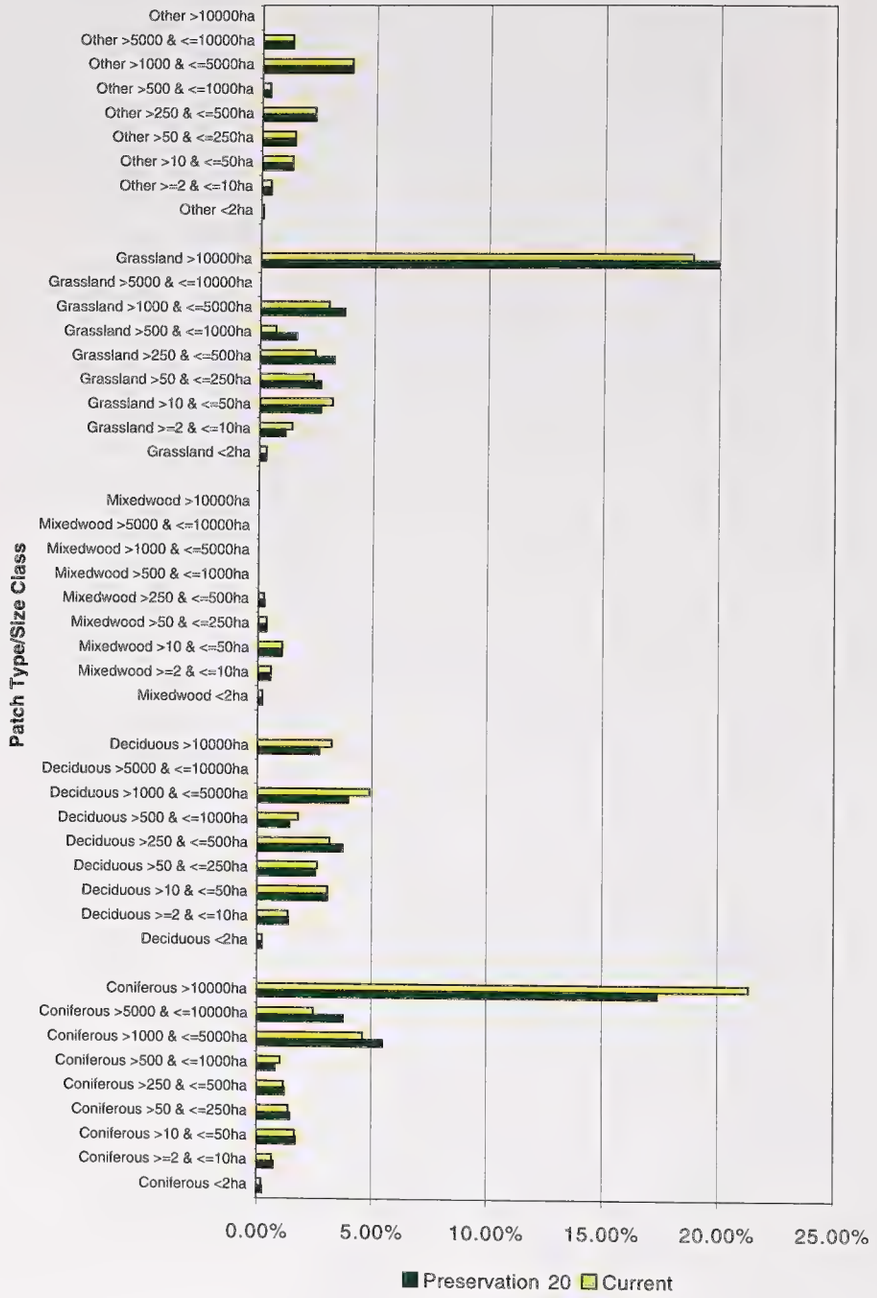


Figure 37. Regional Age Class Distribution – Preservation 20

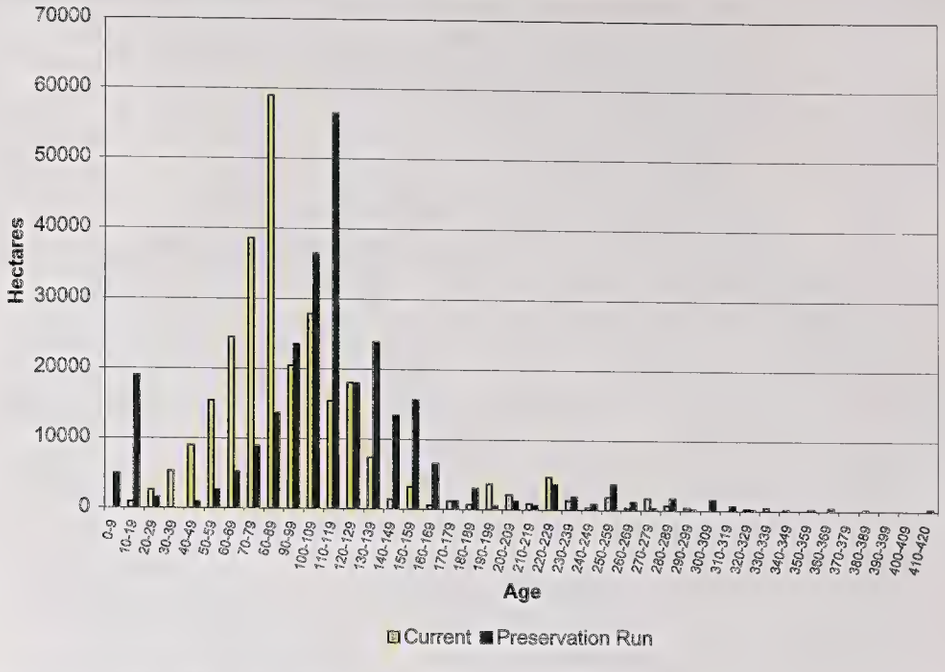


Figure 38. Disturbance Patch Size – Preservation 20

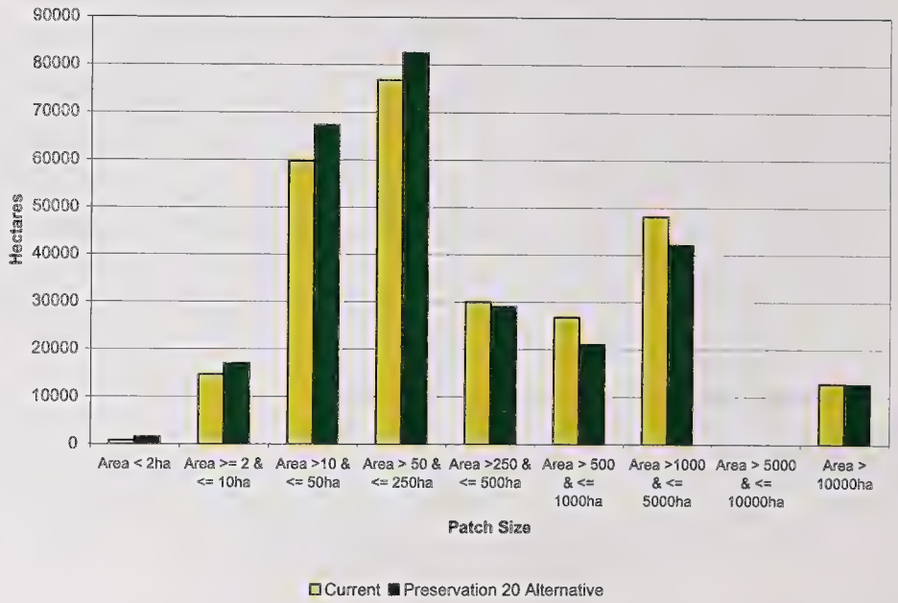


Figure 39. Visualization – West of Livingston Range – Preservation 20

The Preservation Scenario Preservation 50

The Preservation Scenario uses prescribed burning to manage the age class and species composition to ensure that the distribution remains similar to that found in the area around 1950 when effective fire control was beginning to occur. Ecosite phase distribution appears to be very close to current conditions. Aspen and mixedwood are maintained at current levels throughout the scenario. A decrease in pine is indicated and this may be due to succession on sites that were not burned. Otherwise, species distribution is largely maintained throughout the 50–year period.

Age class distribution at Preservation 50 is somewhat younger than current conditions, but quite close to that of 1950. Age class representation across the various cohorts is maintained although with changes to the class areas. Over 3,800 ha are burned each year under a prescription burning program. It appears a more uneven distribution is required in order to more closely approximate the natural disturbance regime. It is unlikely that there would be societal acceptance of the extremely large fire events that occurred historically. It is suggested that future management of the area considers burning an extremely large area periodically, although in smaller patches than the historical regime.

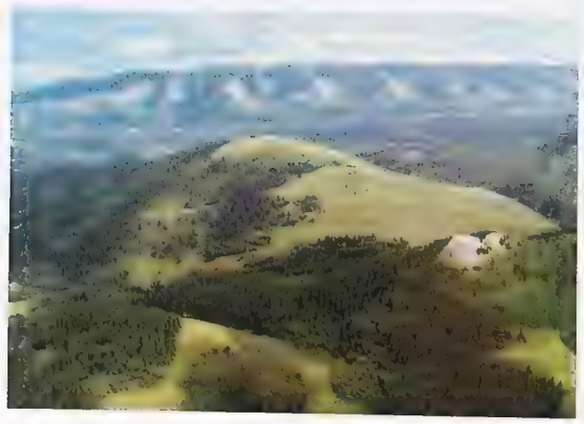
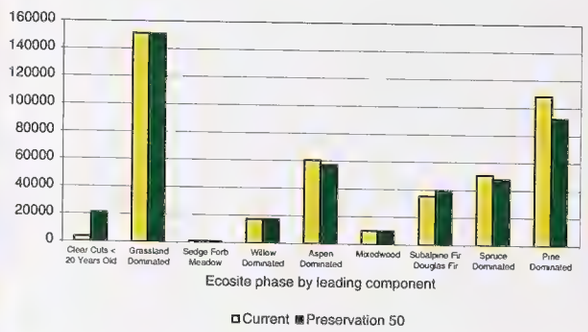
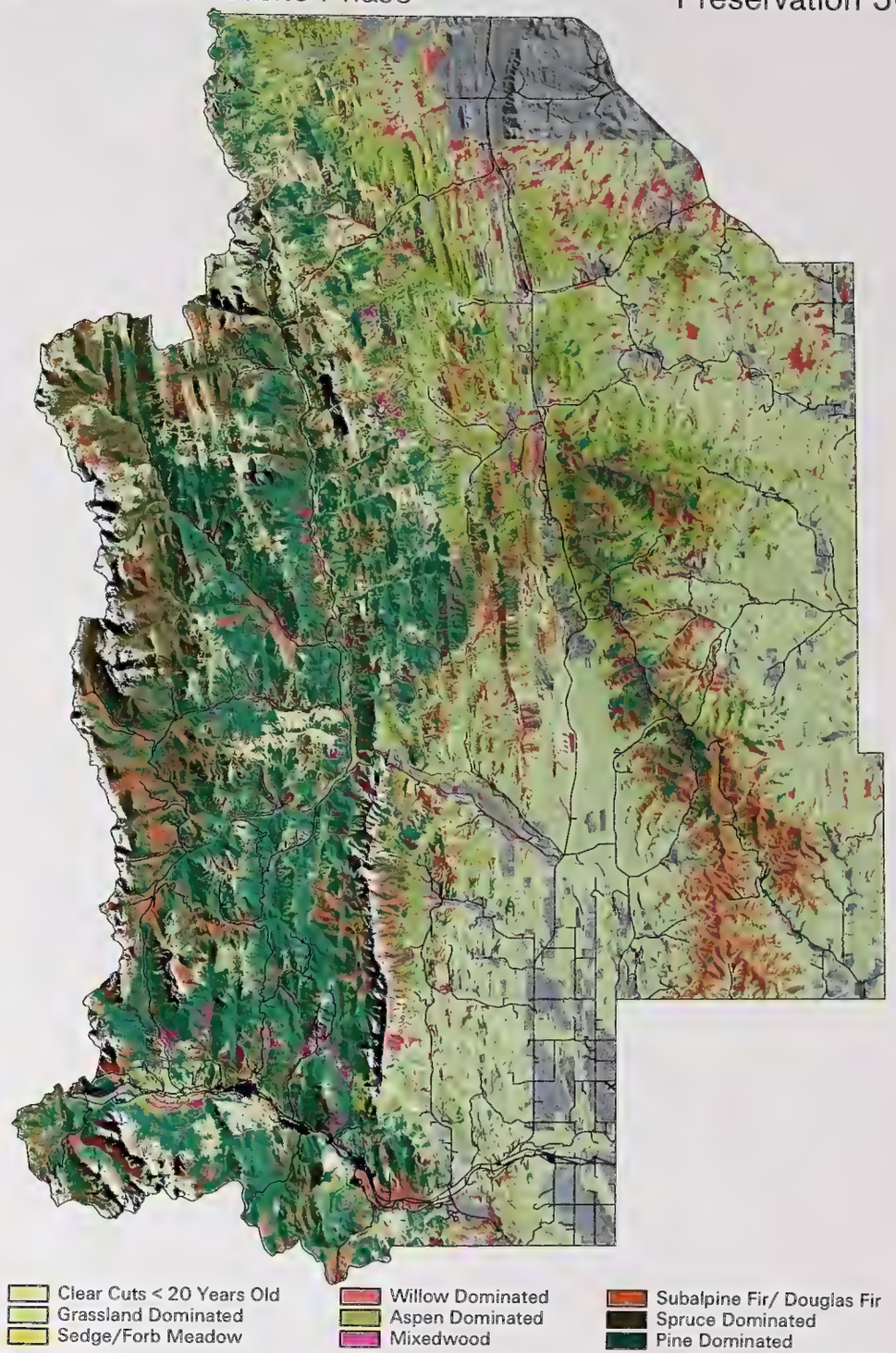


Figure 40 Ecosite Phase by Leading Component – Preservation 50



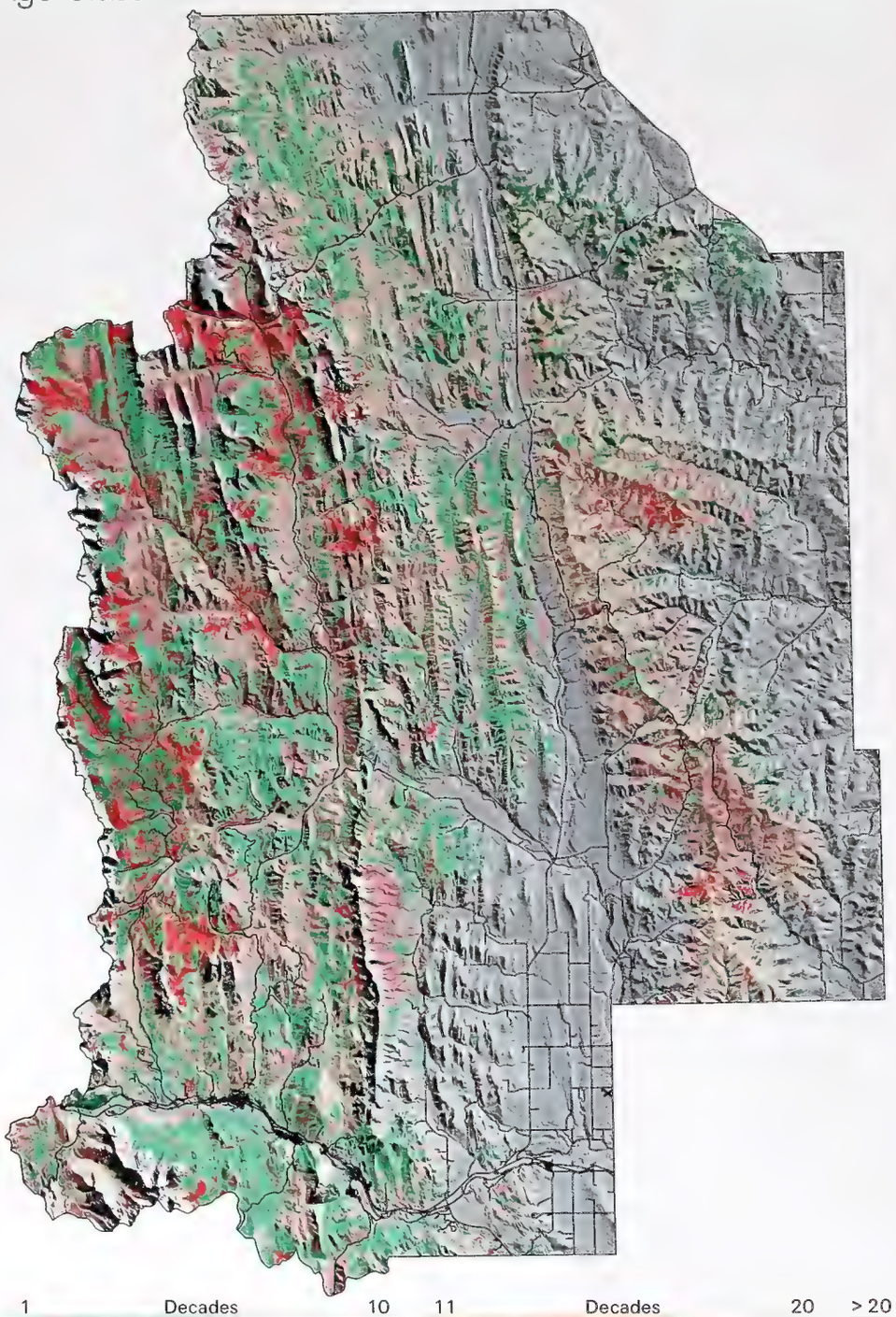
Generalized Ecosite Phase

Preservation 50



Age Class

Preservation 50



Prescribed Burns and Access

Preservation 50

Five Year Cut Periods 1 to 4

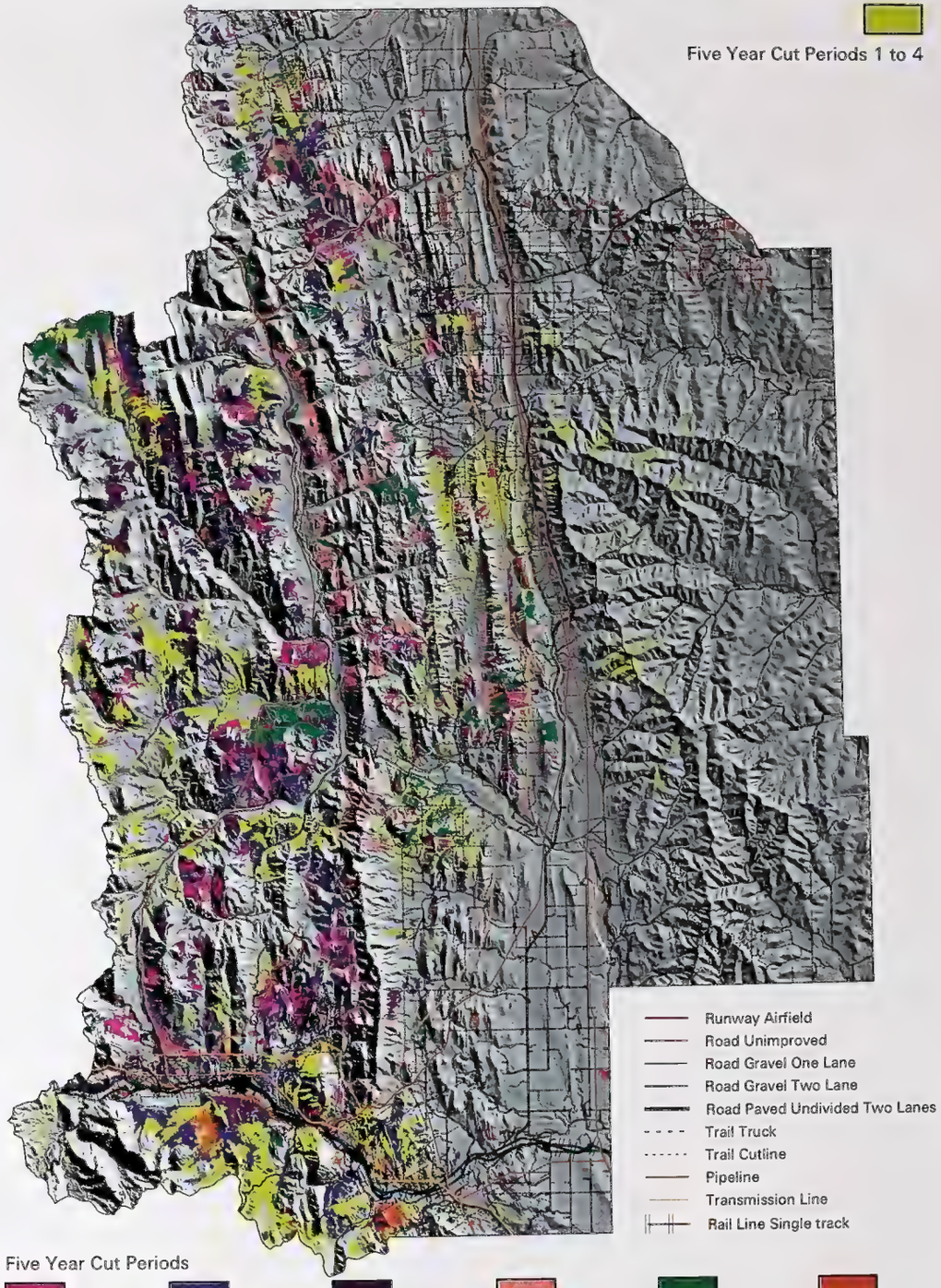


Figure 41. Coniferous, Deciduous, Mixedwood, Grassland, Other Patch Size – Preservation 50

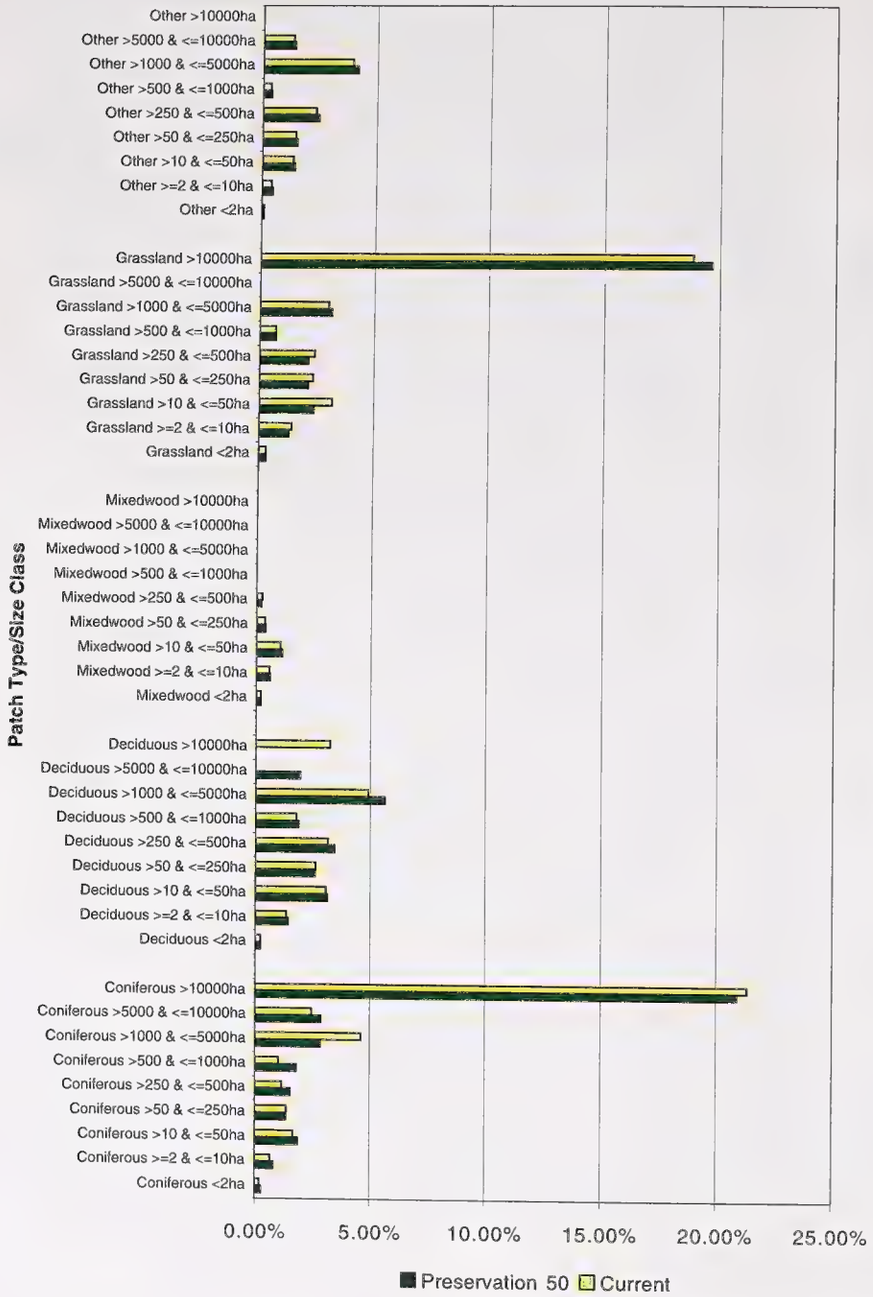


Figure 42. Regional Age Class Distribution – Preservation 50

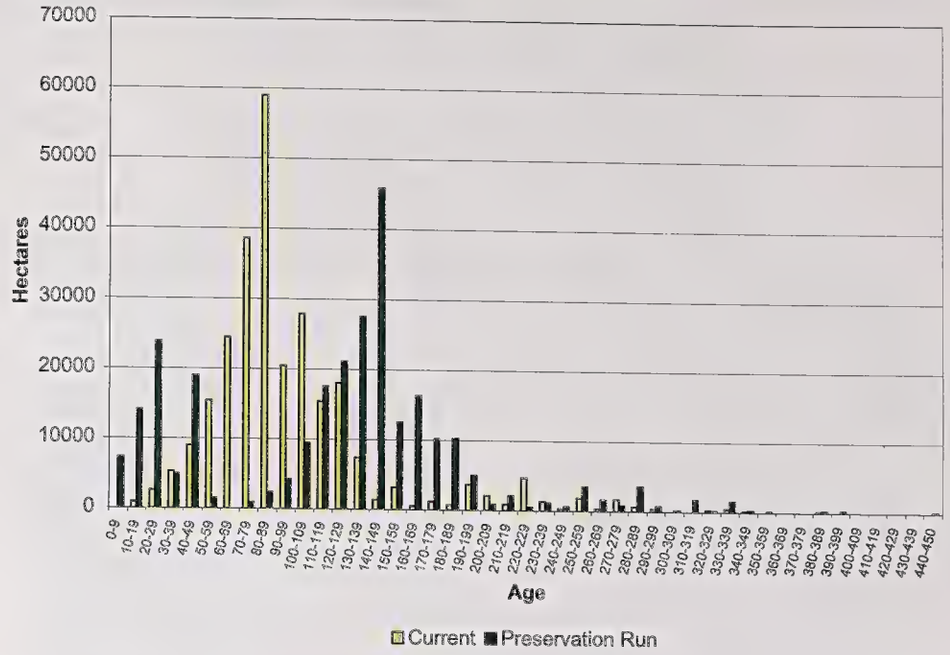


Figure 43. Disturbance Patch Size – Preservation 50

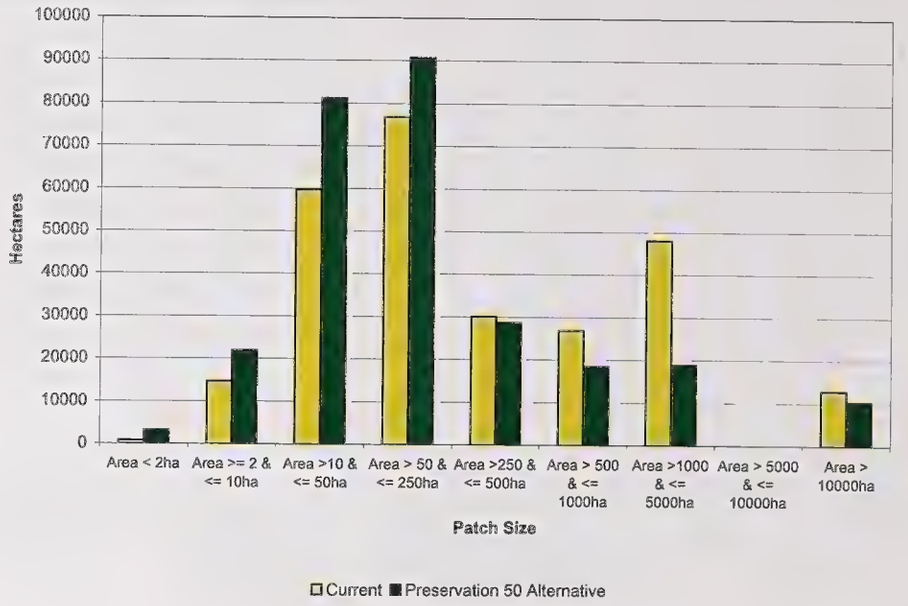
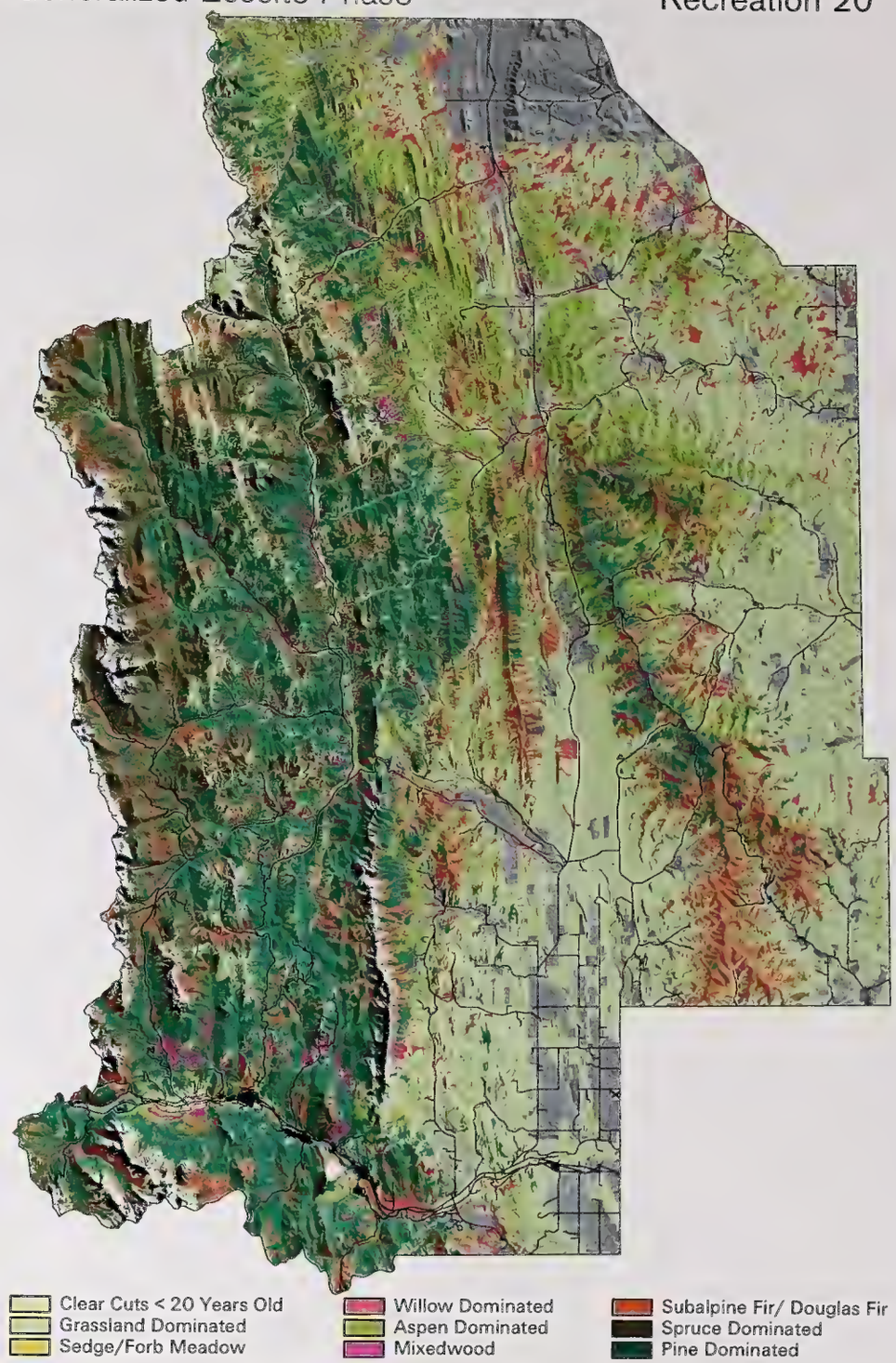


Figure 44. Visualization – West of Livingston Range – Preservation 50

3.6. THE RECREATION SCENARIO

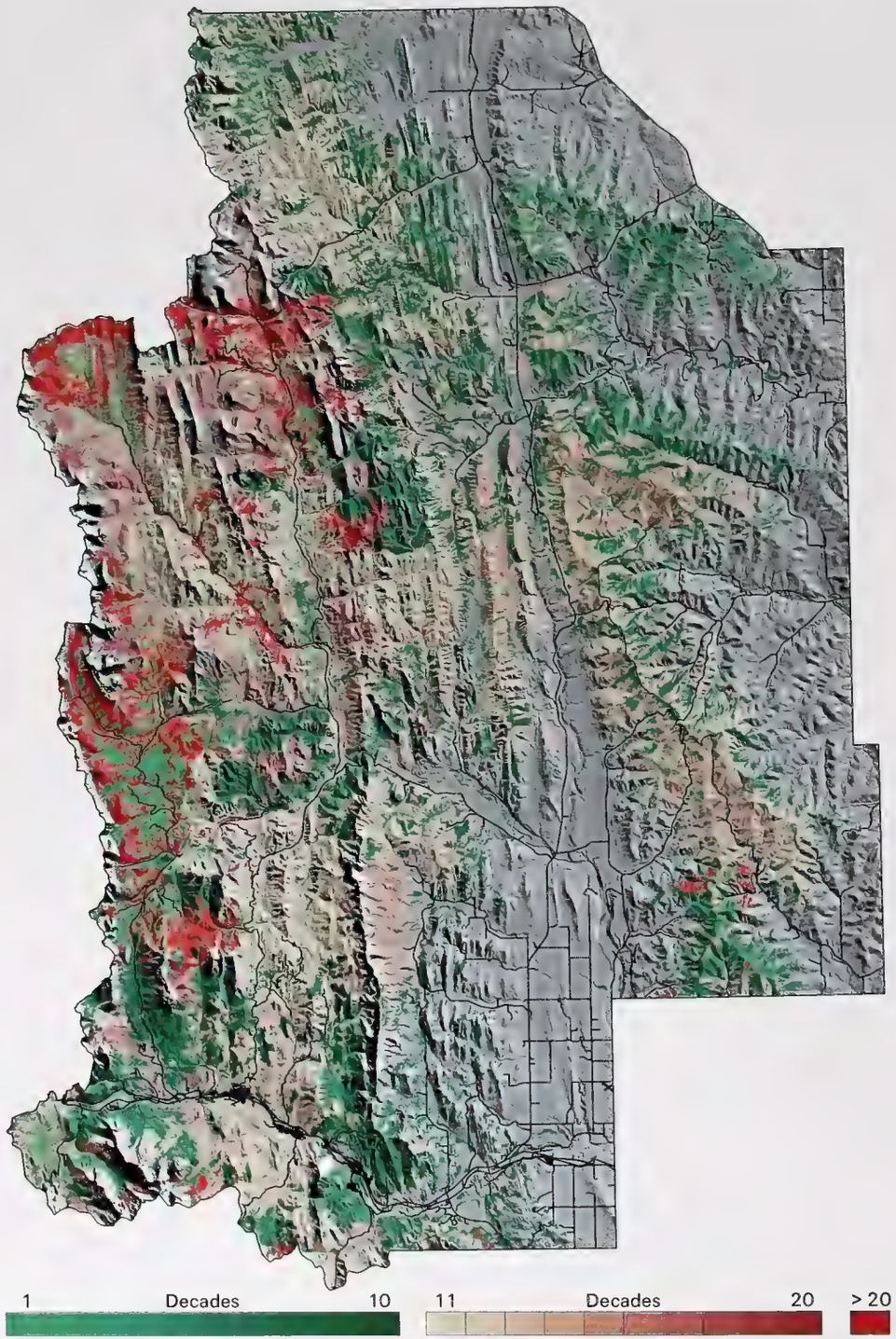
This alternative explores the development of the area with an emphasis on recreational opportunity. A wide range of extensive backcountry and intensive frontcountry recreational uses are accommodated. The following are the assumptions of this alternative:

- harvesting, grazing and industrial activity is permitted only in those areas which do not conflict with recreational objectives
- scenic quality of the area is emphasized, protected and enhanced
- the following Scenic Byways are designated and in some cases upgraded:
  - the Forestry Trunk Road
  - the Skyline Trail in the Porcupine Hills – upgrading/extension of the Skyline Trail north of highway 520
  - the Dutch Creek/Allison Creek Road is considered
- access will be managed to maximize recreational opportunity:
  - some roads are upgraded
- backcountry opportunities are provided:
  - multi–day backcountry opportunities
  - the road is closed at the Old Man Falls
  - access is provided for day hiking trips
  - an extensive trail system of multiple types (hiking, equestrian, bicycle, ski) is constructed/designated and maintained
  - a series of backcountry lodges/cabins is considered
- motorized vehicular use of the backcountry is provided in some areas:
  - a motorized vehicle area similar to the McLean Creek Area is designated in compartment MR5 (north of the Crowsnest Pass)
  - an extensive trail system is designated and maintained
- random vehicular accessed camping areas are designated
- telemark ski areas in association with the cabins/lodges is considered – snowmobile service access to the areas is provided
- villages service centres is considered at the following locations:
  - Porcupine Junction (#22 and #520)
  - at the confluence of the Livingstone and Oldman rivers
  - the village of Maycroft
- golf courses are located in association with the villages service centres
- other lodges are considered on suitable sites
- hunting and fishing is allowed and enhanced:
  - wildlife habitat for huntable or viewable species is enhanced
  - fisheries habitat is enhanced including the development of "put and take" areas
- multi season use of the area is emphasized
- fire control is maximized
- maximum cutblock size = 50 ha
- current minimum cutblock size = 1 ha
- average cutblock size = 10 ha
- regeneration lags determined by ecosite
- percent regeneration failure determined by ecosite
- 50 years are required before adjacent stands can be harvested
- reforestation is to original species
- clearcuts remove 90% volume
- partial cut areas remove between 30% and 50% of the volume
- visual quality and recreational opportunity has been protected by not allowing harvesting in the following areas:
  - all Headwater Valley LMU compartments
  - visible areas from designated trails (within 1 km)
  - visible areas from recreation nodes, campgrounds, staging areas, lodges or major development areas (within 5 km)
  - currently legislated protected areas plus the Whaleback Special Place Area
- Harvesting was also not allowed in the following areas:
  - slopes > 45
  - current subjective deletions
  - areas outside green zone
- partial cut 30% removal area includes stream buffers (1 – 3 order)
- partial put 40% removal area includes stream buffers (4 – 7 order)
- partial cut 50% removal area includes:
  - motorized vehicle zone
  - Crowsnest Pass compartments
  - visibility from main roads



Age Class

Recreation 20



Cutblocks and Access

Recreation 20

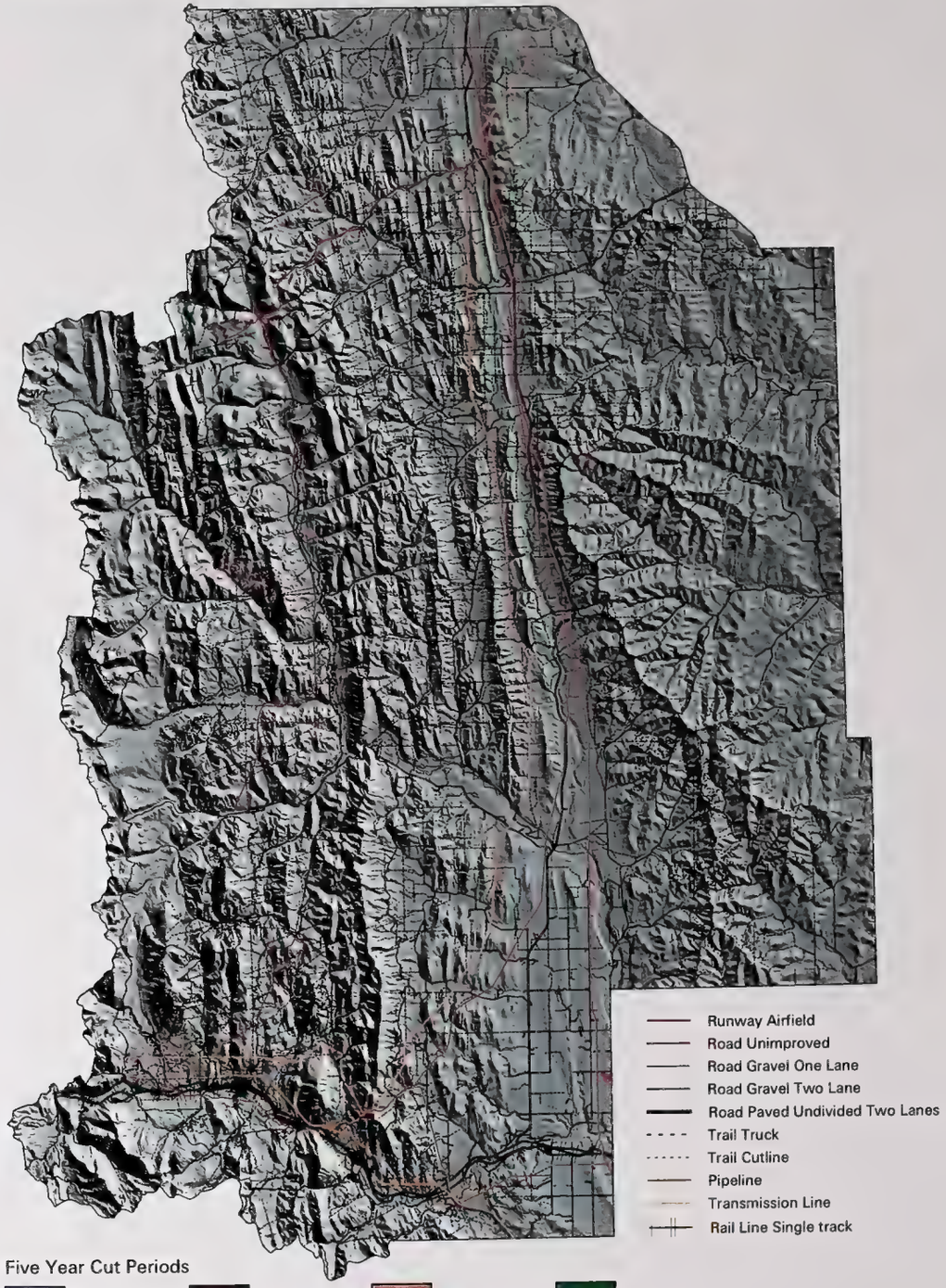


Figure 45. Coniferous, Deciduous, Mixedwood, Grassland, Other Patch Size -- Recreation 20

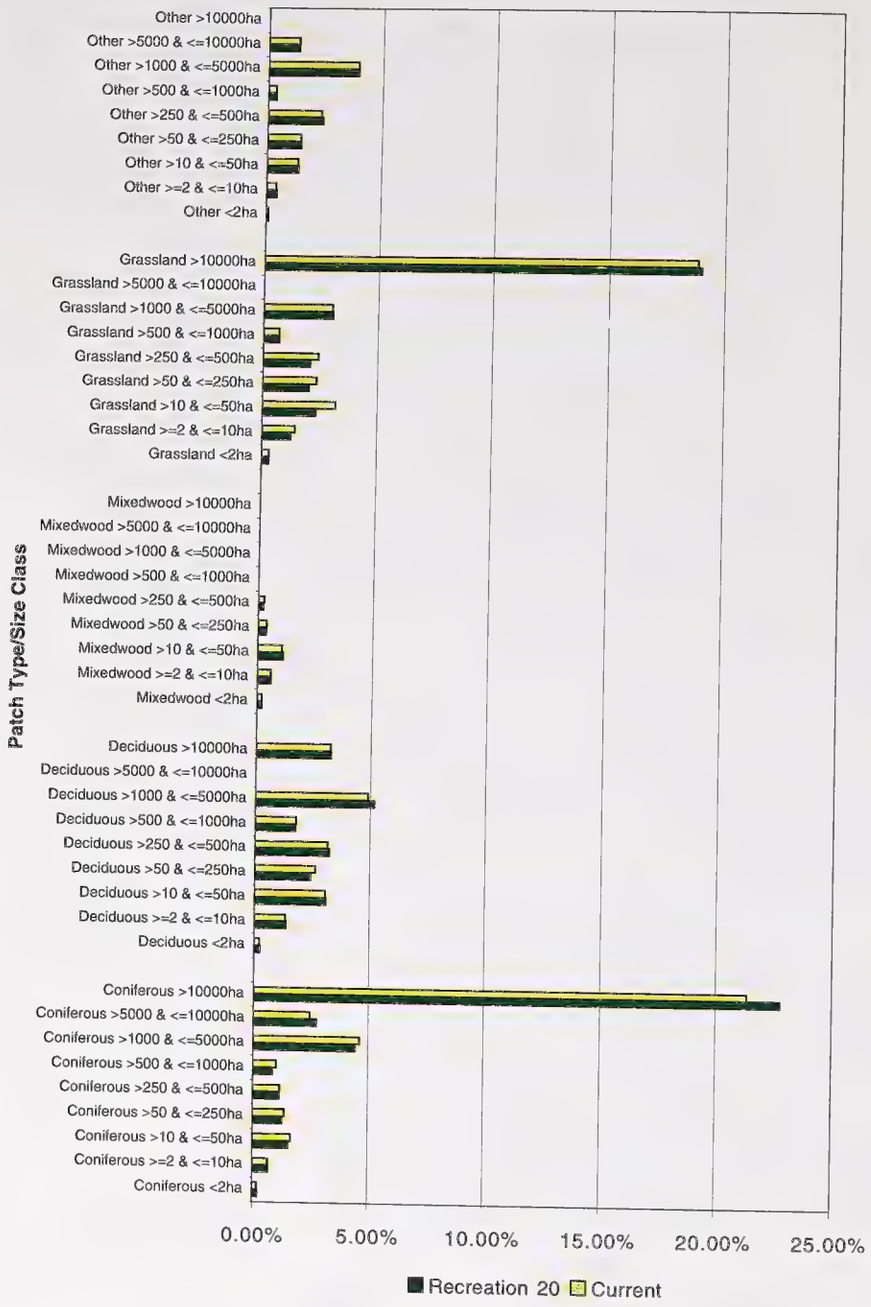


Figure 46. Regional Age Class Distribution -- Recreation 20

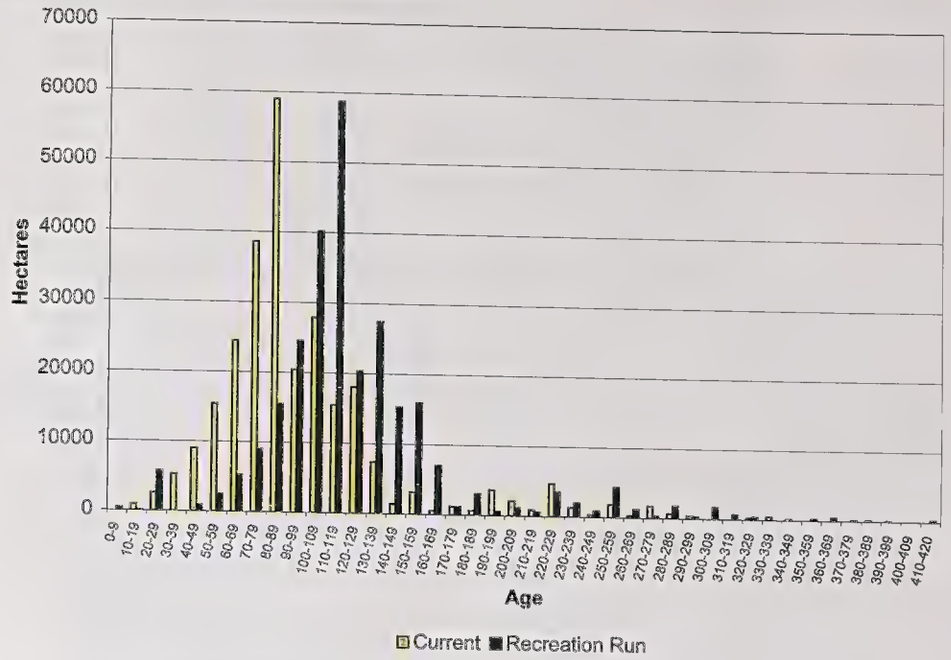


Figure 47. Disturbance Patch Size -- Recreation 20

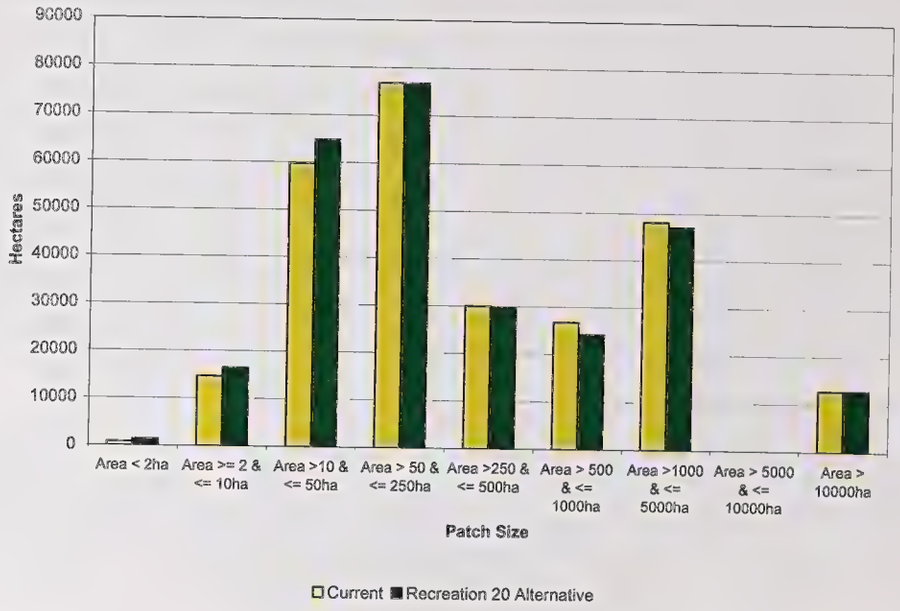


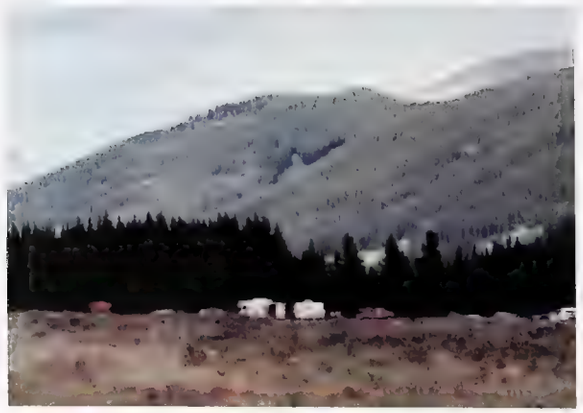
Figure 48. Visualization – West of Livingston Range – Recreation 20

The Recreation Scenario Recreation 50

The Recreation Scenario has the least vegetation management of any scenario. Fire control is assumed to be complete although the possibility of escapes increases as the forest grows older. Species composition is largely maintained, although there is a shift away from pine towards spruce and fir. Succession is occurring throughout the area while disturbance, other than a very small amount of logging, is not.

Age class distribution is very different from that of both the existing conditions and 1950. There is little representation in the younger age classes and this will likely have serious biodiversity implications. Disturbance patch size representation remains nearly identical to the current conditions as little has changed and no new stands have been established.

This alternative establishes recreational centres (hotels, lodges, golf courses, trails and trailheads throughout the area). The map of recreational development indicates some possible locations. A motorized vehicle zone has been established in the compartment north of the Crowsnest Pass. All Headwater Valley LMUs are excluded from logging and offer backcountry hiking opportunities. All vehicles are excluded from that zone.



Recreational Development

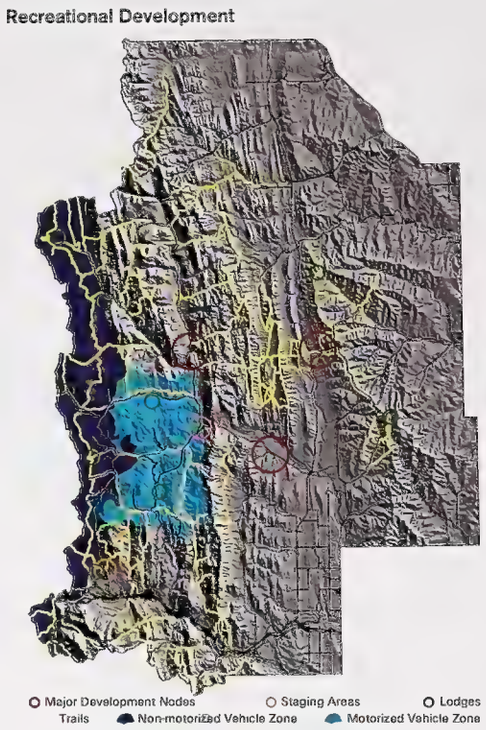
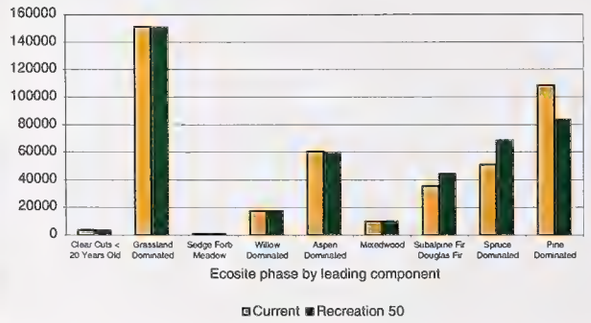
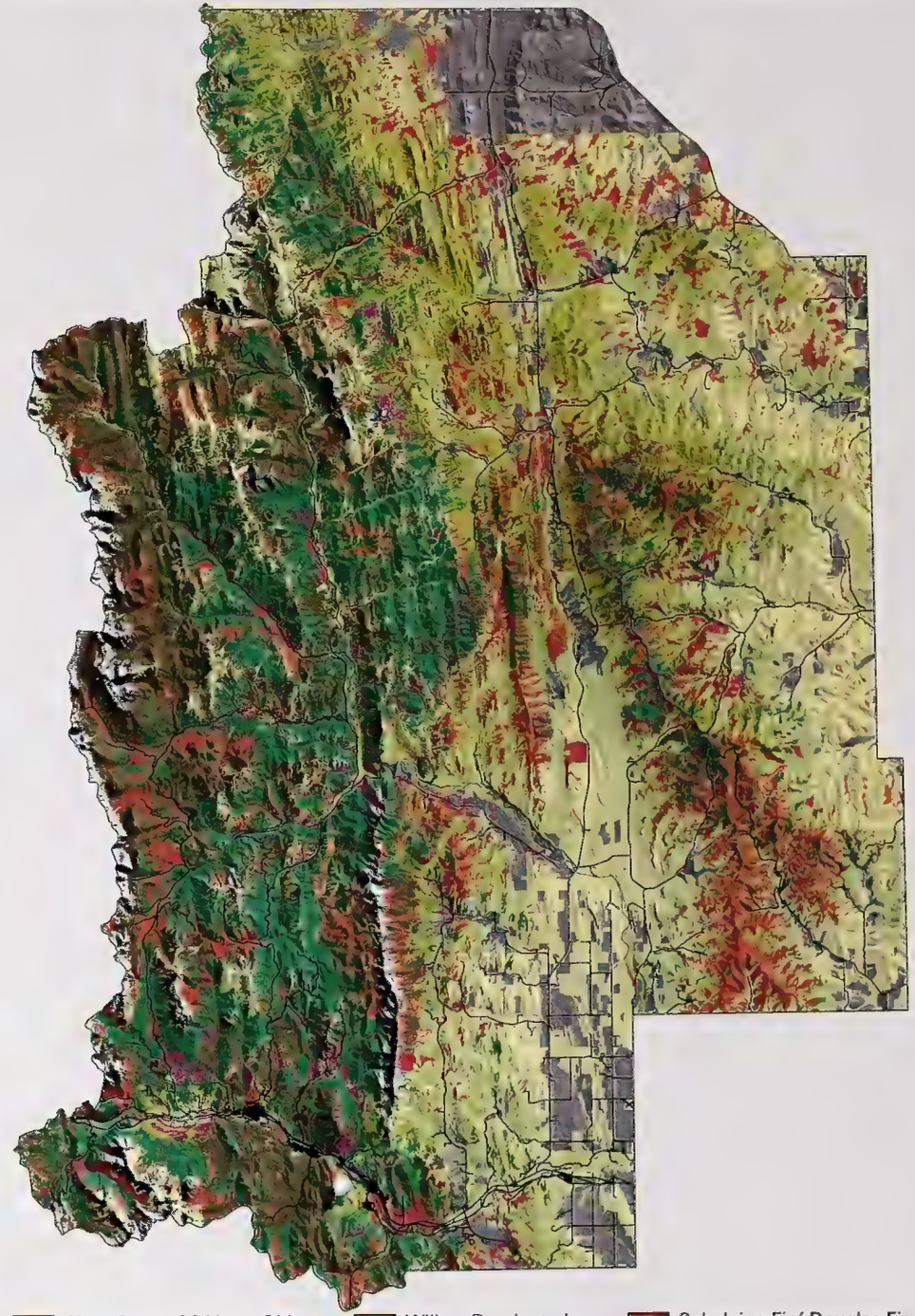


Figure 49. Ecosite Phase by Leading Component – Recreation 50



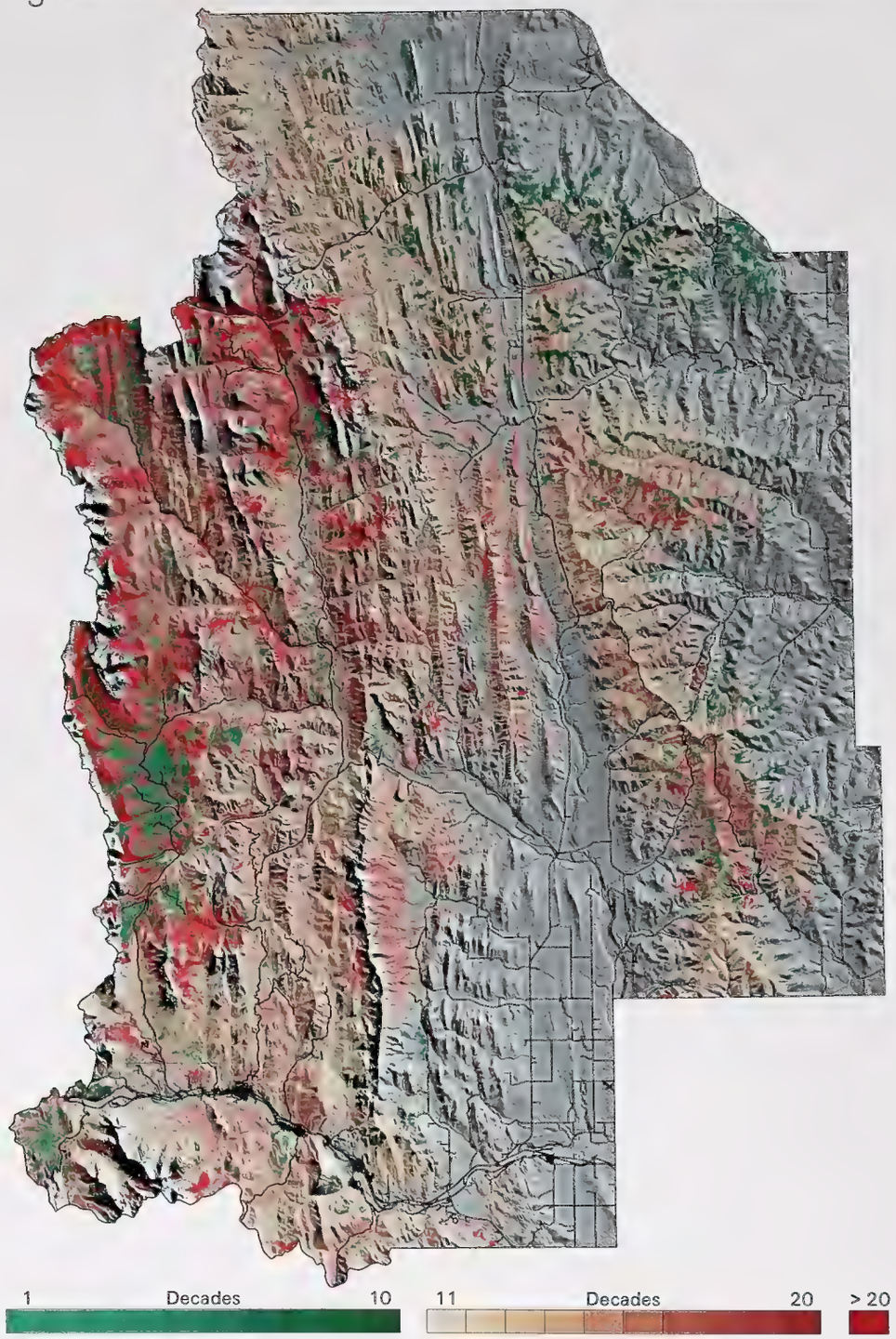
Generalized Ecosite Phase

Recreation 50



Age Class

Recreation 50



Cutblocks and Access

Recreation 50

Five Year Cut Periods 1 to 4

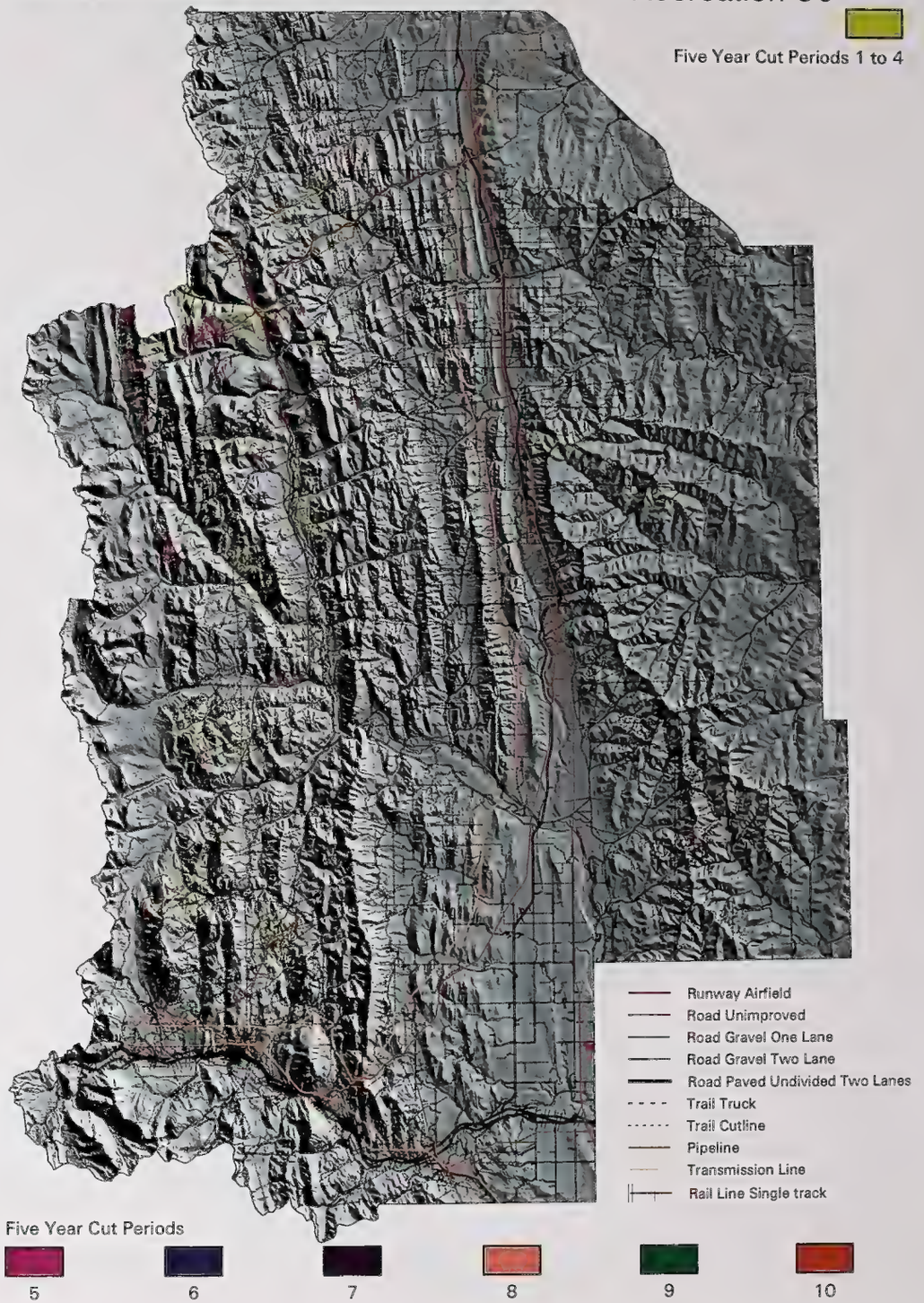


Figure 50. Coniferous, Deciduous, Mixedwood, Grassland, Other Patch Size – Recreation 50

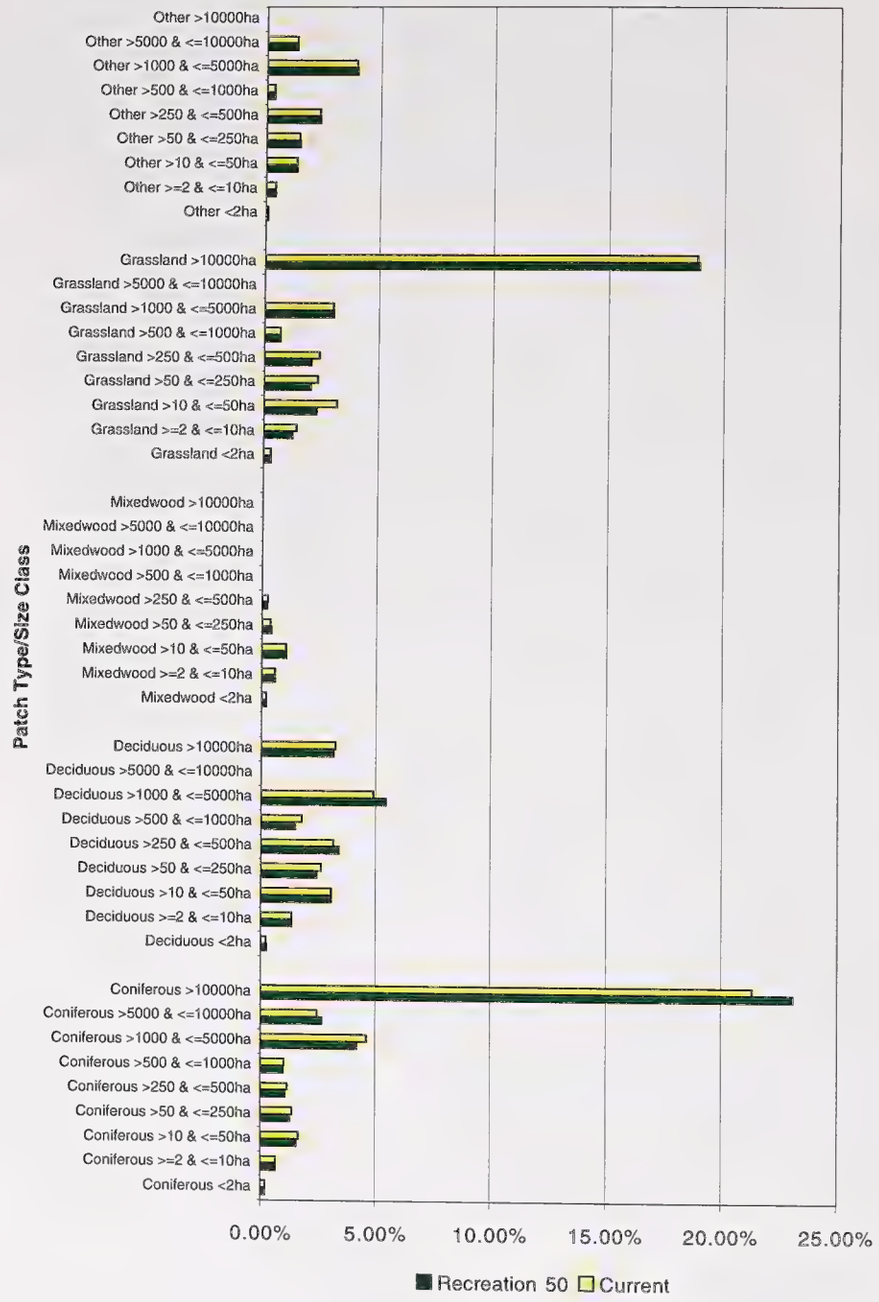


Figure 51. Regional Age Class Distribution – Recreation 50

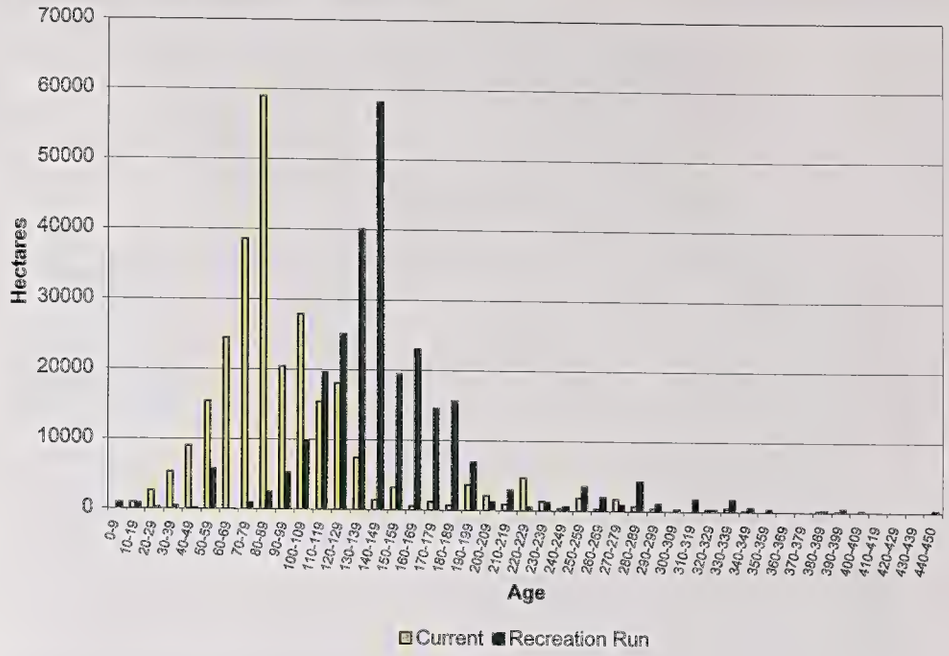


Figure 52. Disturbance Patch Size – Recreation 50

Figure 53. Visualization – West of Livingston Range – Recreation 50

Figure 54. Area of Ecosite Phase Patch Size Classes – All Scenarios

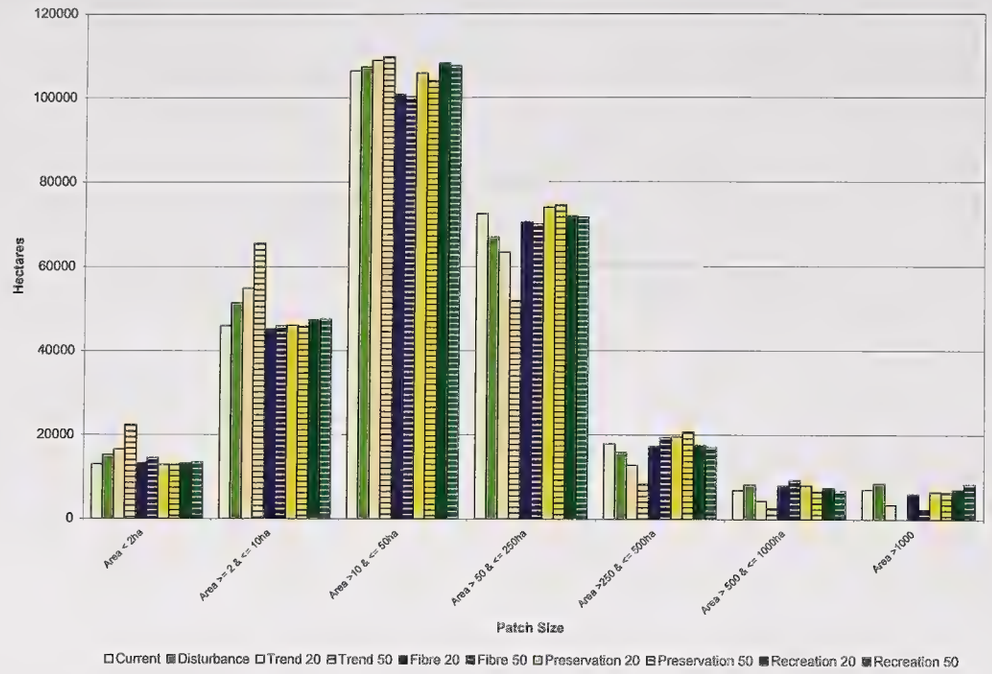


Figure 55. Area of Ecosite Phase by Leading Component – All Scenarios

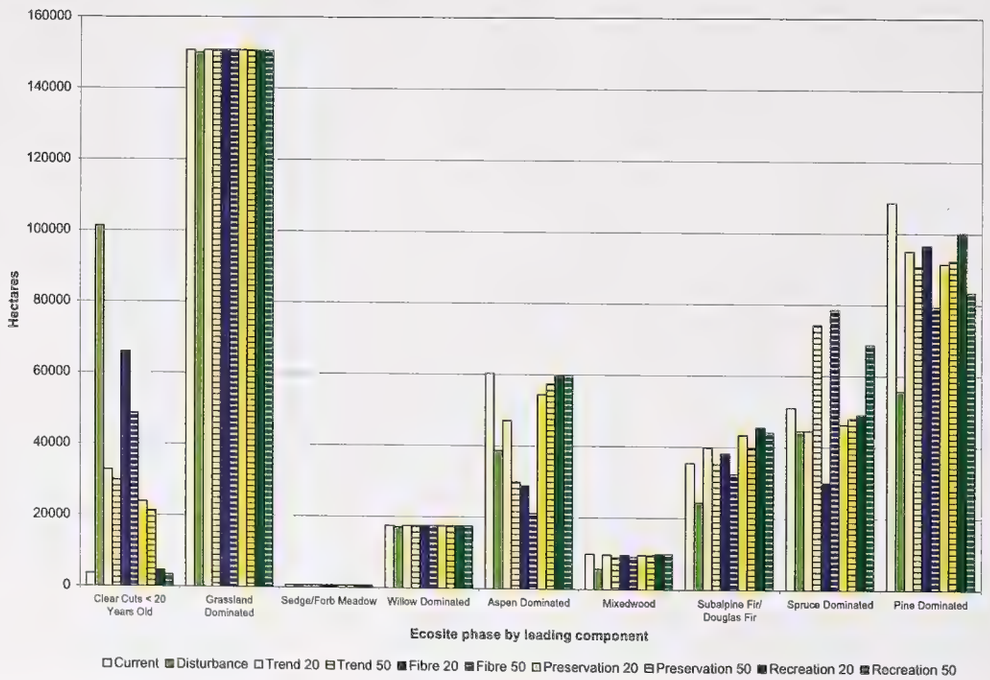
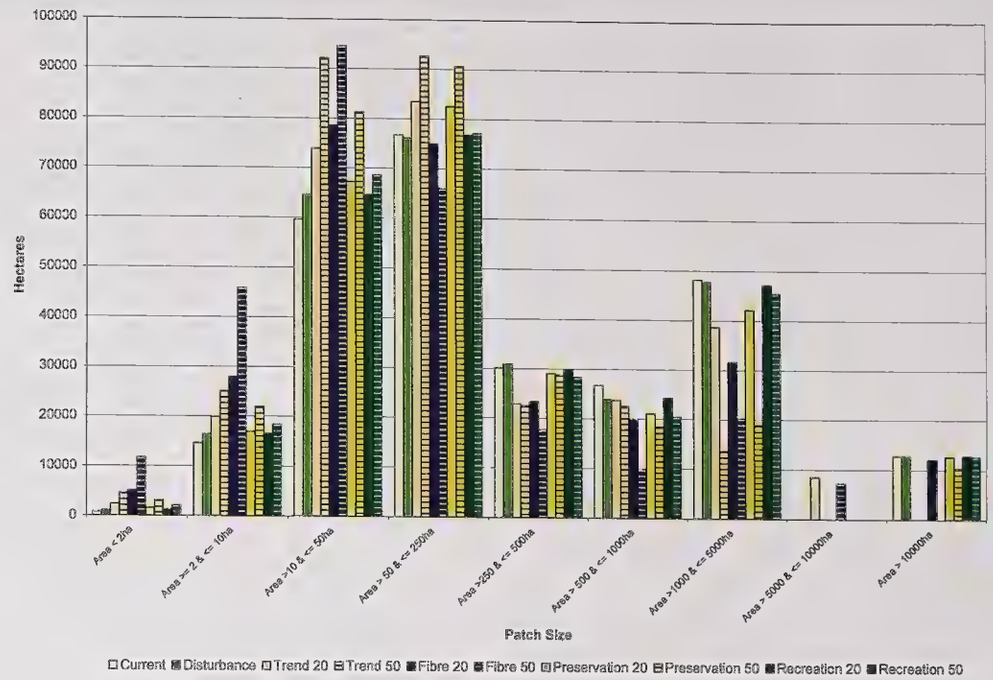


Figure 56. Area of Disturbance Patch Size Classes – All Scenarios



4. Landscape Evaluation and Impact Assessment

Decisions to change the landscape should be based upon clearly stated and measurable criteria. Whether the evaluation is of the existing landscape or of the impacts of alternative future scenarios, decision makers should identify the criteria that they use to judge one condition over another. In this study, criteria that future decision makers are likely to use have been anticipated to establish the set of evaluation and impact models. In order to ensure that such investigations are cost effective, only criteria which are likely to affect decision–making are modelled.

Modelling or direct sampling is required to quantify the impacts and to identify the measurable differences future landscape changes may cause. An initial evaluation of the existing conditions provides a baseline measure against which changes from the past can be assessed and impacts of future change can be compared. The same models are run on both the existing conditions and the future alternatives. The differences between the existing and future conditions reveal how the alternative scenarios impact (either positively or negatively) the criteria upon which decisions are made.

Evaluation and impact models must be spatially explicit, be able to be constructed from available data and describe the conditions within acceptable limits of certainty. The following three categories of evaluation and impact models have been developed:

1. Ecological Models
2. Visual/Cultural Models
3. Economic Models

Within these categories, individual models have been constructed to serve as a suite of impact measures. The impacts of various alternatives are judged in the decision process where the priorities of the models, as well as their importance to various landscape management units, are identified.

Integral to the development of evaluation and impact models is the understanding of the processes operating within the landscape (including the functional and structural relationship among its elements). The following sections describe the evaluation and impact models and their associated processes.

The models included:

Biodiversity Assessment
- Single Species Potential Habitat Abundance
- Avian Diversity
- Ecosite Phase Diversity
- Landscape Ecological Pattern
- Protection of Rare, Unique and Valued Elements

Watershed Risk Assessment (IWAP)
Surface Water Quantity and Timing (WRENNS)
Flammability and Head Fire Intensity
Visual Quality Models
- Visual Landscape Preference
- Visual Exposure
- Visual Value

Cultural Resource Protection
Economic Evaluation and Impact Models

4.1. BIODIVERSITY ASSESSMENT

The rate of decline of biological diversity worldwide is unprecedented and is cause for increasing concern. The study area contains some of the most biologically diverse areas in the province and warrants protection and careful management. The intersection of several natural subregions together with a high diversity of physiographic and vegetational conditions has led to the richness of the area. In order to provide a comprehensive assessment of biodiversity that addresses both local and broad scale requirements, several approaches have been taken including assessment of the following:

- habitat abundance of wildlife species of special concern
- conservation of essential broad scale landscape patterns
- conservation of rare and unique elements
- the interspersion of local landscape elements
- avian diversity

Habitat Abundance of Species of Special Concern
The single species potential habitat models map the potential habitats of selected vertebrates based on food and vegetation structural requirements. In addition to providing a test of the coarse filter conservation approach, there are other advantages to including at least a limited number of individual species in any regional assessment. In many cases, management needs to consider species specific requirements that would not be captured in a more general approach. In others, threatened species need to be considered. In addition, some species clearly demonstrate the impact of landscape fragmentation and are likely to be representative of the broad landscape requirements of other species.

Avian Diversity
Based on field sampling of vegetation cover types, the importance to avian diversity was mapped across the region. The importance values of the habitat types were used to indicate changes in potential species richness resulting from habitat alteration under the various scenarios. The avian diversity modelling does not address specific species, but rather, the total importance of the cover type to many species.

Protection of Landscape Pattern
The relationship between generalized landscape structure and essential landscape processes has increasingly been the object of study. Many scientists have indicated the importance of retaining "indispensable patterns" (Forman, 1995) that provide the basis for the protection of critical landscape elements and functions. These essential patterns have been quantified for each scenario.

Protection of Rare and Unique Elements
The protection afforded special elements within the region has been modelled for each scenario.

Interspersion of Local Landscape Elements (Ecosite Phase Diversity)
Many species require several different types of habitat within a small area. The impact of the scenarios on local ecosite phase diversity has been quantified.

4.1.1. SPECIES OF SPECIAL CONCERN

The seven wildlife species described in the following sections have been selected on the basis of their requirements for specific landscape conditions; thereby serving as indicators of environmental change that may indicate concerns for other species. Species were chosen on the basis of:
- sensitivity to human land use activities and habitat alterations
- rare, threatened or endangered status
- social and economic importance
- sensitivity to changes in hydrology and riparian vegetation
- dependence on disturbances and early successional habitat types
- dependence on late successional, old growth habitat types
- large home range multi landscaped spatial requirements
- knowledge of species habitat requirements for the area

4.1.1.1. GRIZZLY BEAR

(Ursus arctos horribilus)

The following is a summary of key components of the Grizzly Potential Habitat Model. Details of the model are available in the wildlife model summary papers. The model assesses changes to potential grizzly habitat under alternative land use and management scenarios. At present, there are no model calibration efforts, such as animal telemetry studies, underway. The model has been designed for use at the landscape, subregional and regional scales and is not intended for use at the individual stand level. It has been developed for the following seasons:

- Pre Berry Season: April, May, June, July
- Post Berry Season: August, September, October

MODEL STRUCTURE

The model is raster or grid cell based and has been constructed using ERDAS Imagine 8.3 and MapFactory software. The model has 4 main components or sets of outputs (refer to diagram):

1. Rating of Food Value Importance (potential)
2. Identification of Zones and Degrees of Human Influence
3. Food Habitat Effectiveness Calculation
4. Neighbourhood Foraging Value Assessment (potential and effective)

Food Value Importance Index (FVII)

Ecosite phases and their predicted associated plant communities were assigned a grizzly bear food importance value (VTIV) based, in part, upon ratings of vegetation in the method of Kansas et al. (1995). These importance values were assigned on a monthly basis for the months of April through October. Food values or VTIV sums (after Kansas and Riddell, 1995) by ecosite by month were computed. The importance values were then averaged by season (pre berry and post berry) and converted to a 0 to 4 Food Value Importance Index (FVII). The potential food value index for the period April to October was calculated by averaging the monthly values and then recoding according to the rating scheme previously mentioned. The average potential values for both the pre berry and post berry seasons were also calculated and mapped.

Zones and Degrees of Human Influence

Distance from cover as well as the presence of access (roads, trails, etc.) and other aspects of human use greatly alter the effectiveness of grizzly bear habitat. Various man made features and human activities have differing zones and degrees of influence. This portion of the model classifies land use features and identifies zones and intensity of influence. The proximity to other land uses/features, as well as the presence or absence of cover, will also influence habitat effectiveness.

Human access is of particular concern because of the adverse bear/human interactions which reduce effective utilization of the habitat by bears. For the purposes of this model, access has been classified into three categories:

Access Type A – All Weather: paved roads, gravel two lane, gravel one lane, main rail lines
Access Type B – Good Weather: unimproved roads, truck trails, spur rail lines
Access Type C – Backcountry: trail/cutline and utility corridor

Suitability index values were established for the distance from various access types. These values are used to multiply the food value ratings and therefore may reduce the effectiveness of habitat mapped in previous stages.

Food Habitat Effectiveness

Calculation of Habitat Effectiveness Index (HEI)

The effects of various human uses are cumulative. The suitability index (SI) coefficients are multiplied together to produce a map of the product of all suitability indices for each pixel. This is then used to reduce the value (or retain if there is no influence) of the potential food value importance index (FVII) for an individual pixel. This yields maps of food habitat effectiveness for both the pre and post berry seasons.

Neighbourhood Foraging Value

The foraging value of a pixel of habitat is based not only upon the value of the pixel itself, but also on the amount and quality of habitat surrounding it. Analysis of both the initial food value index and the effective habitat index was carried out within two spatial areas:

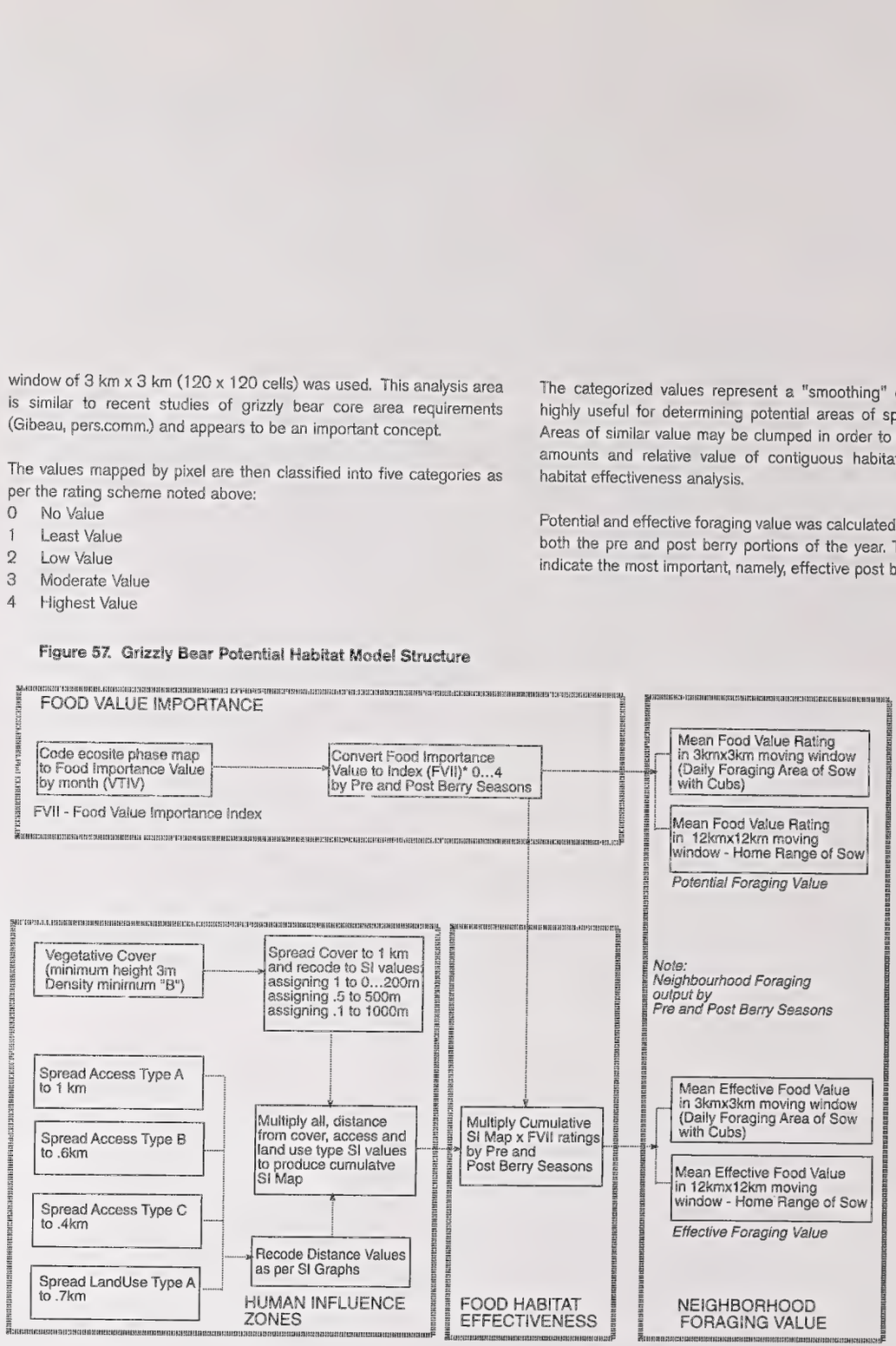
- the average daily foraging area of a sow grizzly with cubs (approximately 9 km²)
- the annual home range of a sow grizzly (144 km²)

The pixel resolution of the spatial database was 25 m x 25 m or 0.0625 ha. A focal mean neighbourhood operation was conducted on the seasonal and the total values within a square moving window area of analysis. In the case of the average daily foraging area, a moving window of 3 km x 3 km (120 x 120 cells) was used. This analysis area is similar to recent studies of grizzly bear core area requirements (Gibeau, pers.comm.) and appears to be an important concept.

The values mapped by pixel are then classified into five categories as per the rating scheme noted above:

0 No Value
1 Least Value
2 Low Value
3 Moderate Value
4 Highest Value

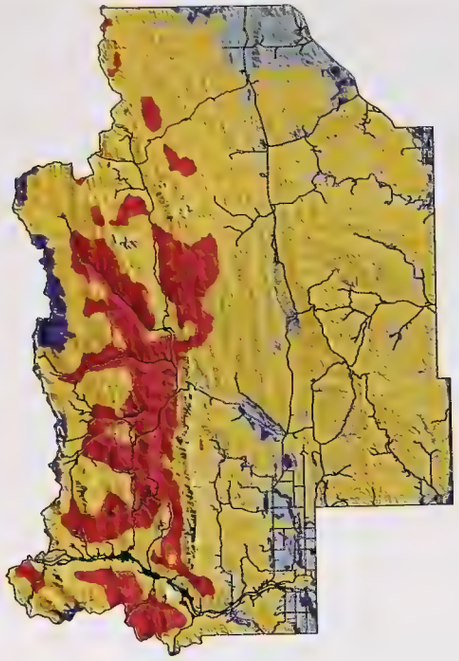
Figure 57. Grizzly Bear Potential Habitat Model Structure


FOOD VALUE IMPORTANCE
Code ecosite phase map to Food Importance Value by month (VTIV)
Convert Food Importance Value to Index (FVII)* 0...4 by Pre and Post Berry Seasons
FVII - Food Value Importance Index
Mean Food Value Rating in 3kmx3km moving window (Daily Foraging Area of Sow with Cubs)
Mean Food Value Rating in 12kmx12km moving window - Home Range of Sow
Potential Foraging Value
Vegetative Cover (minimum height 3m Density minimum "B")
Spread Cover to 1 km and recode to SI values assigning 1 to 0...200m assigning .5 to 500m assigning .1 to 1000m
Note: Neighbourhood Foraging output by Pre and Post Berry Seasons
Spread Access Type A to 1 km
Spread Access Type B to .6km
Spread Access Type C to .4km
Spread LandUse Type A to .7km
Multiply all, distance from cover, access and land use type SI values to produce cumulatve SI Map
Recode Distance Values as per SI Graphs
HUMAN INFLUENCE ZONES
Multiply Cumulative SI Map x FVII ratings by Pre and Post Berry Seasons
FOOD HABITAT EFFECTIVENESS
Mean Effective Food Value in 3kmx3km moving window (Daily Foraging Area of Sow with Cubs)
Mean Effective Food Value in 12kmx12km moving window - Home Range of Sow
Effective Foraging Value
NEIGHBORHOOD FORAGING VALUE

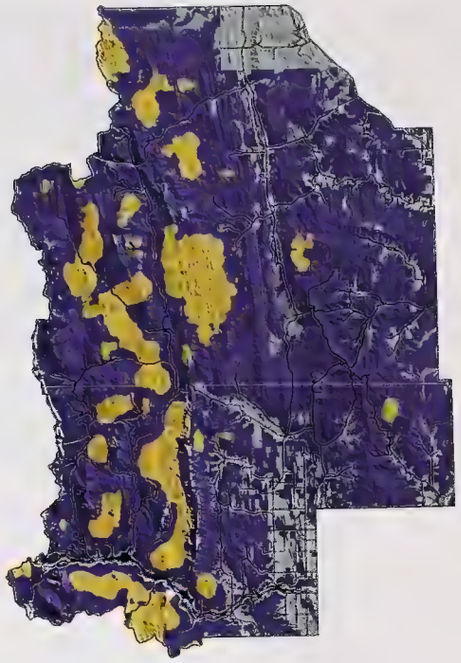
The categorized values represent a "smoothing" of the data that is highly useful for determining potential areas of special management. Areas of similar value may be clumped in order to determine the total amounts and relative value of contiguous habitat available prior to habitat effectiveness analysis.

Potential and effective foraging value was calculated for all scenarios for both the pre and post berry portions of the year. The following maps indicate the most important, namely, effective post berry habitat.

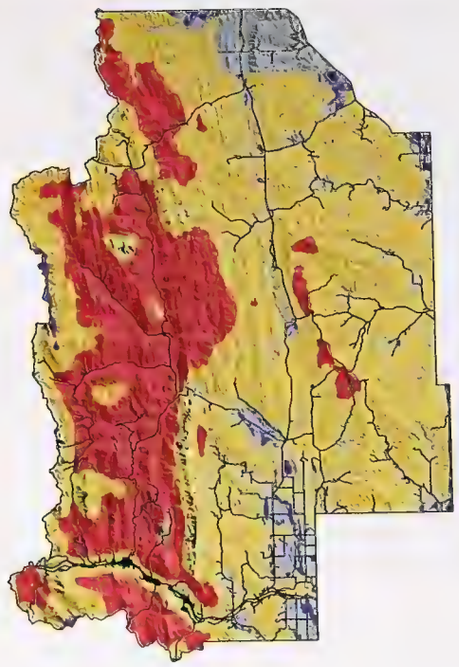
Grizzly, Pre Berry – Potential Habitat Value – Fibre 20



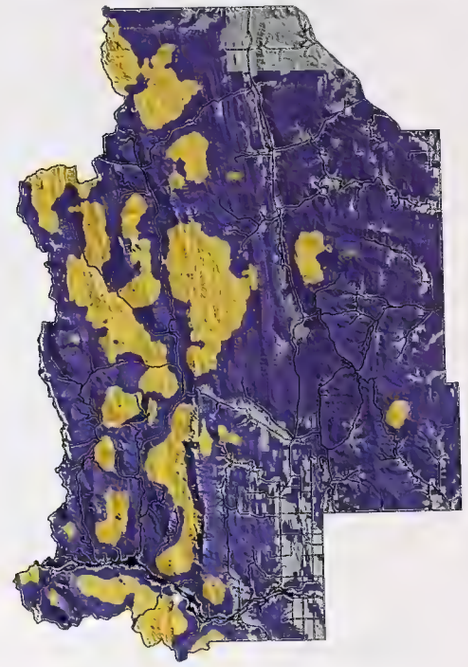
Grizzly, Pre Berry – Effective Habitat Value – Fibre 20



Grizzly, Post Berry – Potential Habitat Value – Fibre 20



Grizzly, Post Berry – Effective Habitat Value – Fibre 20



Vegetation composition and proximity to roads and other human uses were the main variables driving habitat value. As food values were based upon ecosite phase, changes due to different stages of stand development were difficult to model.

The impact of the various scenarios on grizzly habitat varied significantly, primarily due to the amount of access. The Trend Scenario, both at 20 and 50 years, caused a considerable decline in habitat value primarily due to an increase in both the density and distribution of roads. Roads constructed in this alternative are extensive and, under current policy, are likely to remain open to the public once built. Important regional corridors, such as the one to the west of the Livingstone Range, are severely impacted and, in the case of Trend 50, are lost. Future habitat conditions under the Trend are not good.

The Disturbance Scenario had little effect on grizzly habitat, causing only a slight decline in habitat value. This decline could be expected to rebound rapidly following establishment of new plant communities on the burn area.

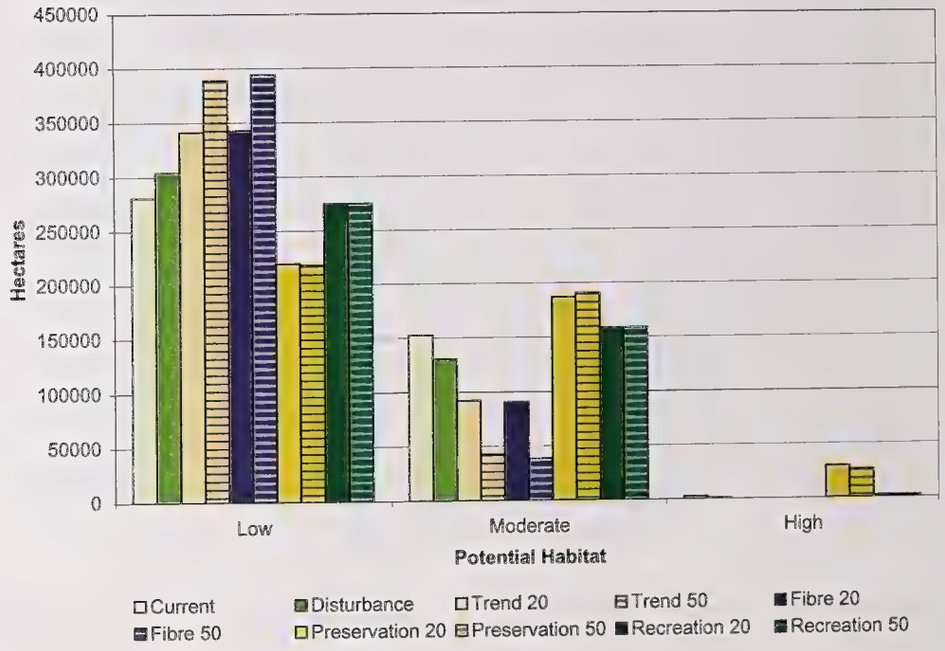
The Fibre Scenario had the highest impact on habitat value. While potential habitat increases under this alternative, effective habit is significantly reduced due to uncontrolled access. All of the highest category habitat disappears under this alternative and even the moderate category is highly fragmented. As grizzly bears are a species which require large contiguous patches of habitat, this scenario puts the species at considerable risk.

The Preservation Scenario had a positive impact on grizzly habitat, primarily due to removal of access. Vegetation communities are maintained through burning, but the majority of the current backcountry access is removed throughout the forest reserve. A significant increase in the area of the highest value effective habitat is realized.

The Recreation Scenario also results in an increase in the value of grizzly habitat. While a small amount of harvesting takes place and new trails and a motorized vehicle zone are implemented, all major roads and truck trails are removed from the headwater valleys. The access reduction is the main cause of the improvement in habitat.

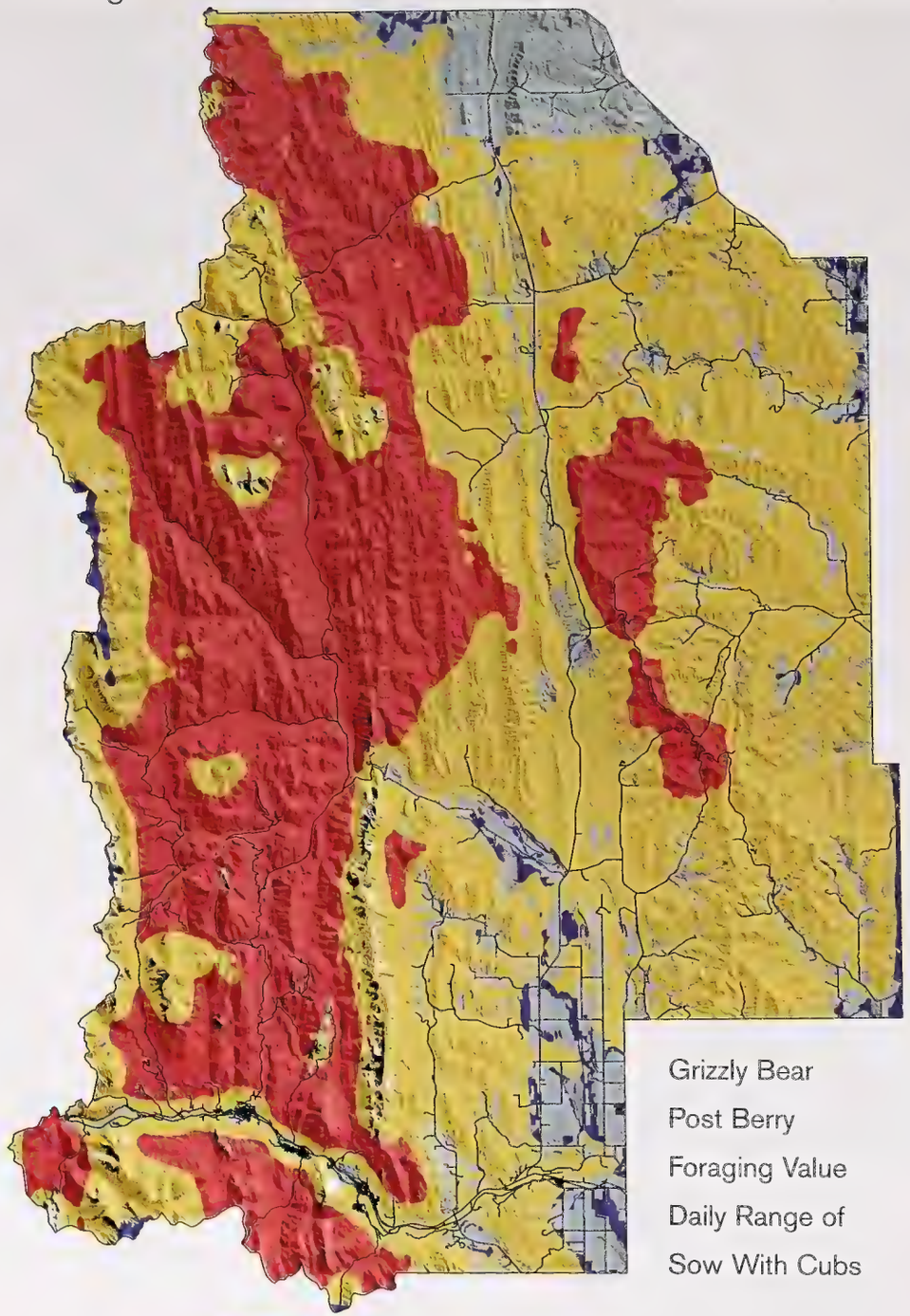
It is clear that access is the single most important variable in the model. Harvesting, burning and fire control all effect vegetation food value importance. However, aside from hunting, access management appears to be the most powerful grizzly bear management tool.

Fig 58. Grizzly, Post Berry – Effective Habitat Value – Scenarios Comparison



Existing

Potential Habitat

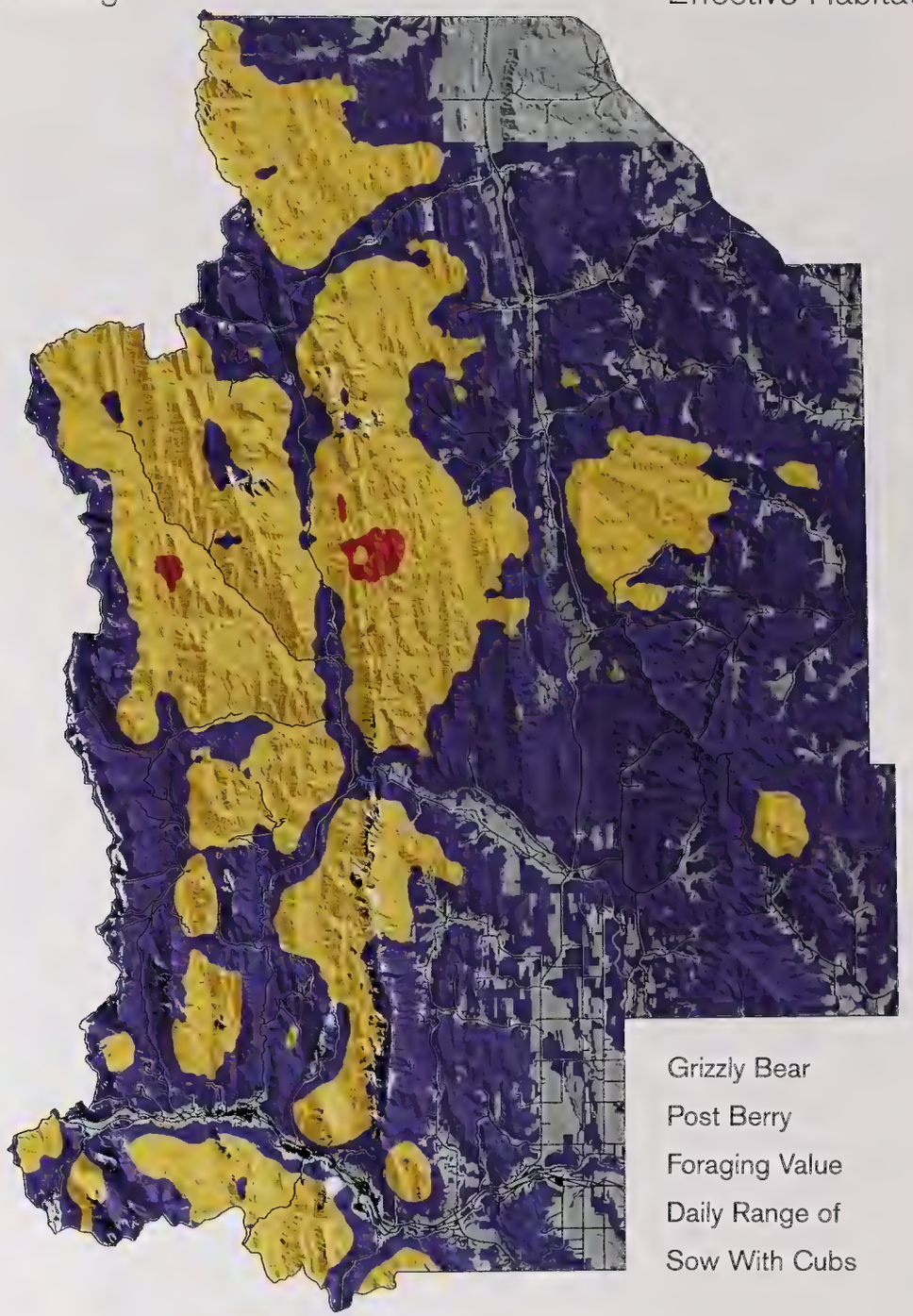


Grizzly Bear
Post Berry
Foraging Value
Daily Range of
Sow With Cubs

Lowest Moderate Highest

Existing

Effective Habitat

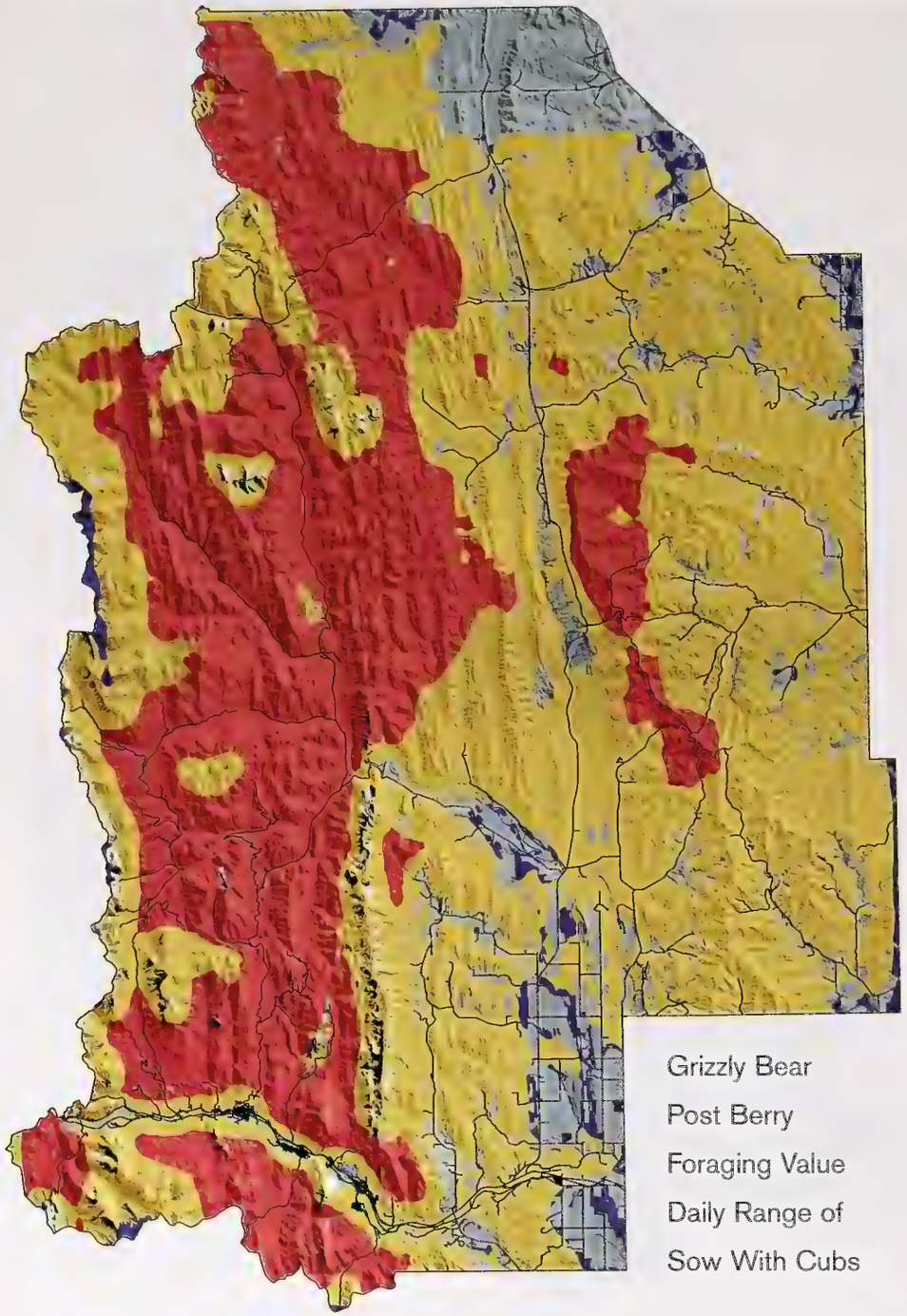


Grizzly Bear
Post Berry
Foraging Value
Daily Range of
Sow With Cubs

Lowest Moderate Highest

Disturbance

Potential Habitat

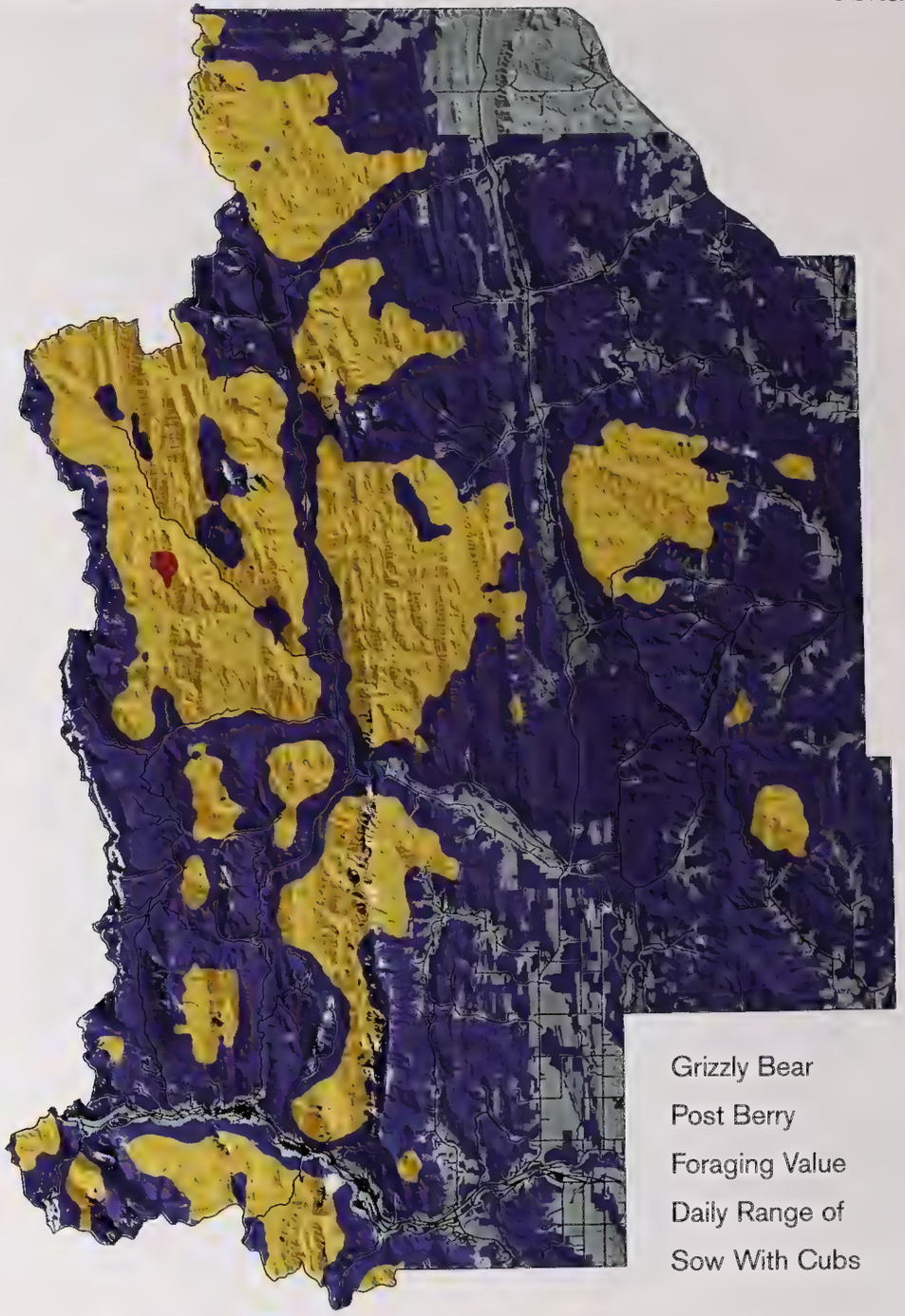


Grizzly Bear
Post Berry
Foraging Value
Daily Range of
Sow With Cubs

Lowest Moderate Highest

Disturbance

Effective Habitat

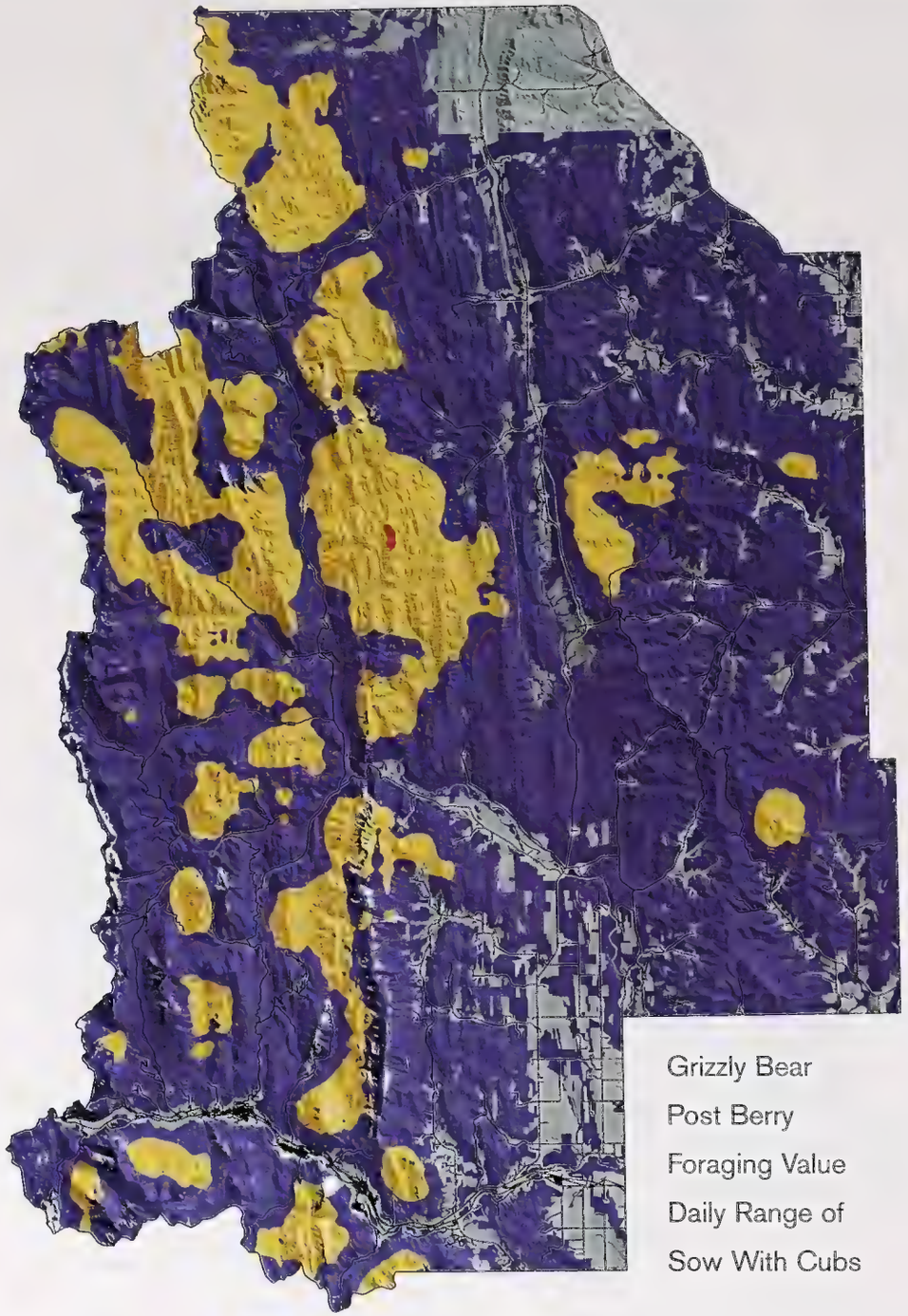


Grizzly Bear
Post Berry
Foraging Value
Daily Range of
Sow With Cubs

Lowest Moderate Highest

Trend 20

Effective Habitat

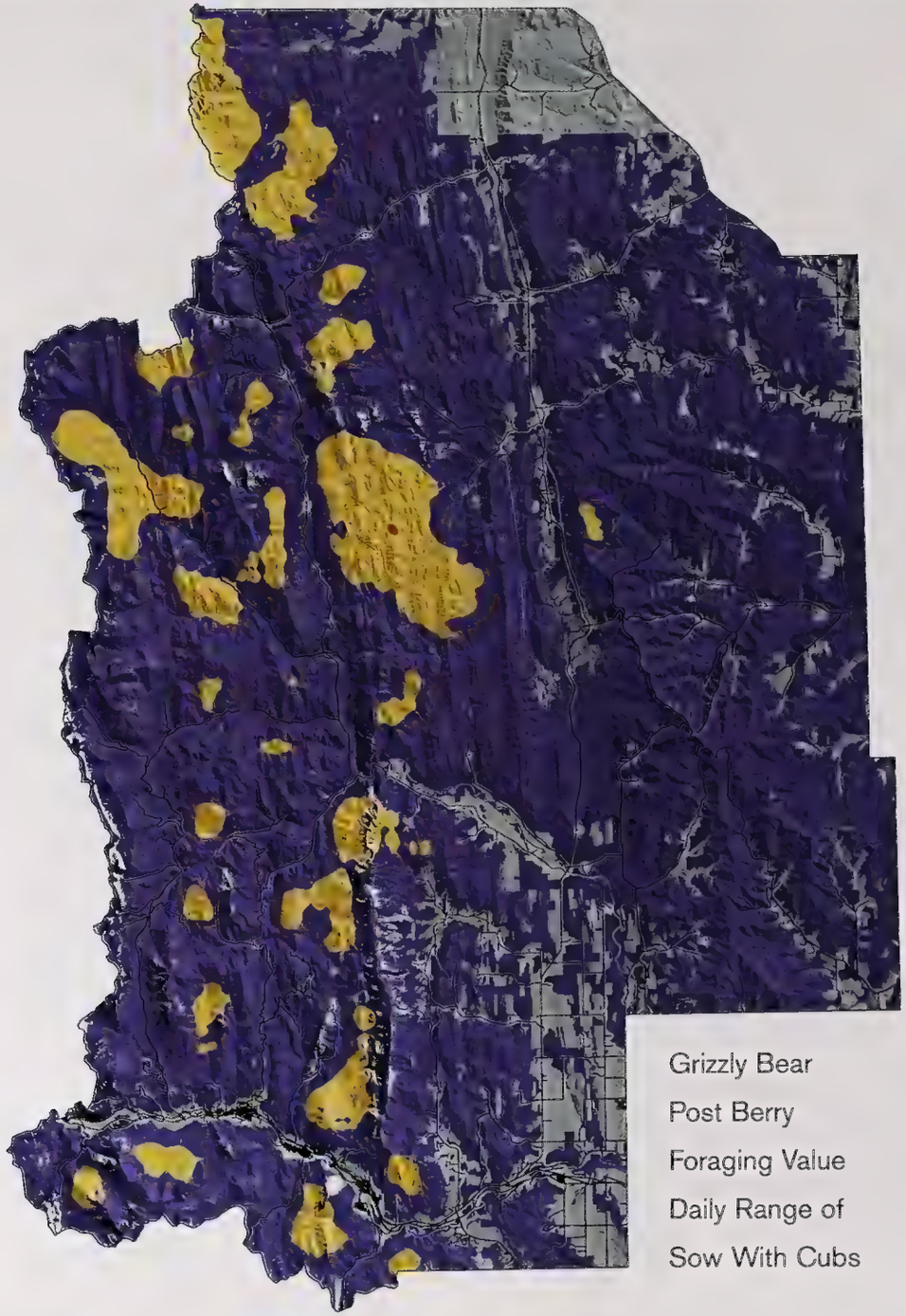


Grizzly Bear
Post Berry
Foraging Value
Daily Range of
Sow With Cubs

Lowest Moderate Highest

Trend 50

Effective Habitat

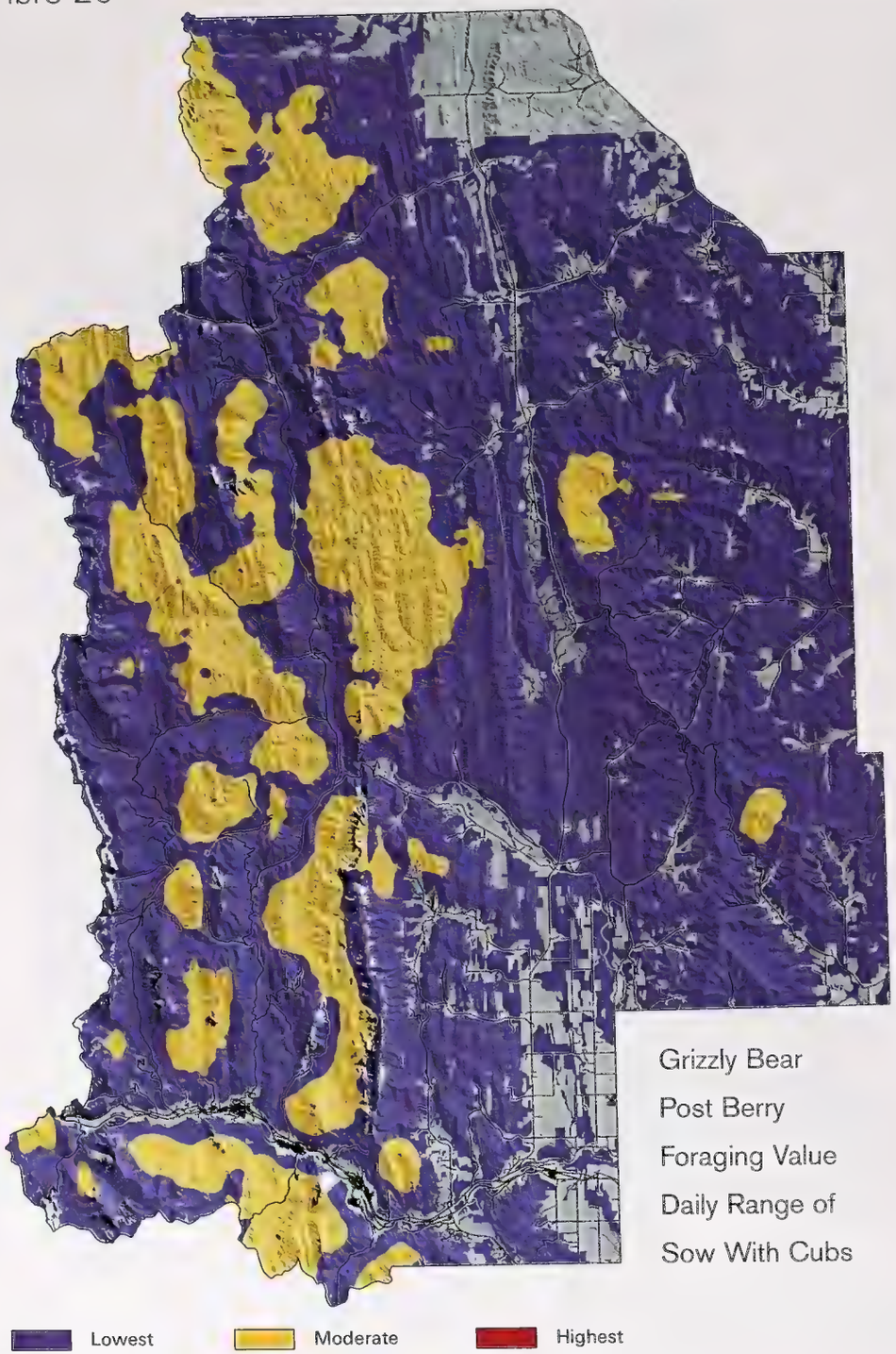


Grizzly Bear
Post Berry
Foraging Value
Daily Range of
Sow With Cubs

Lowest Moderate Highest

Fibre 20

Effective Habitat

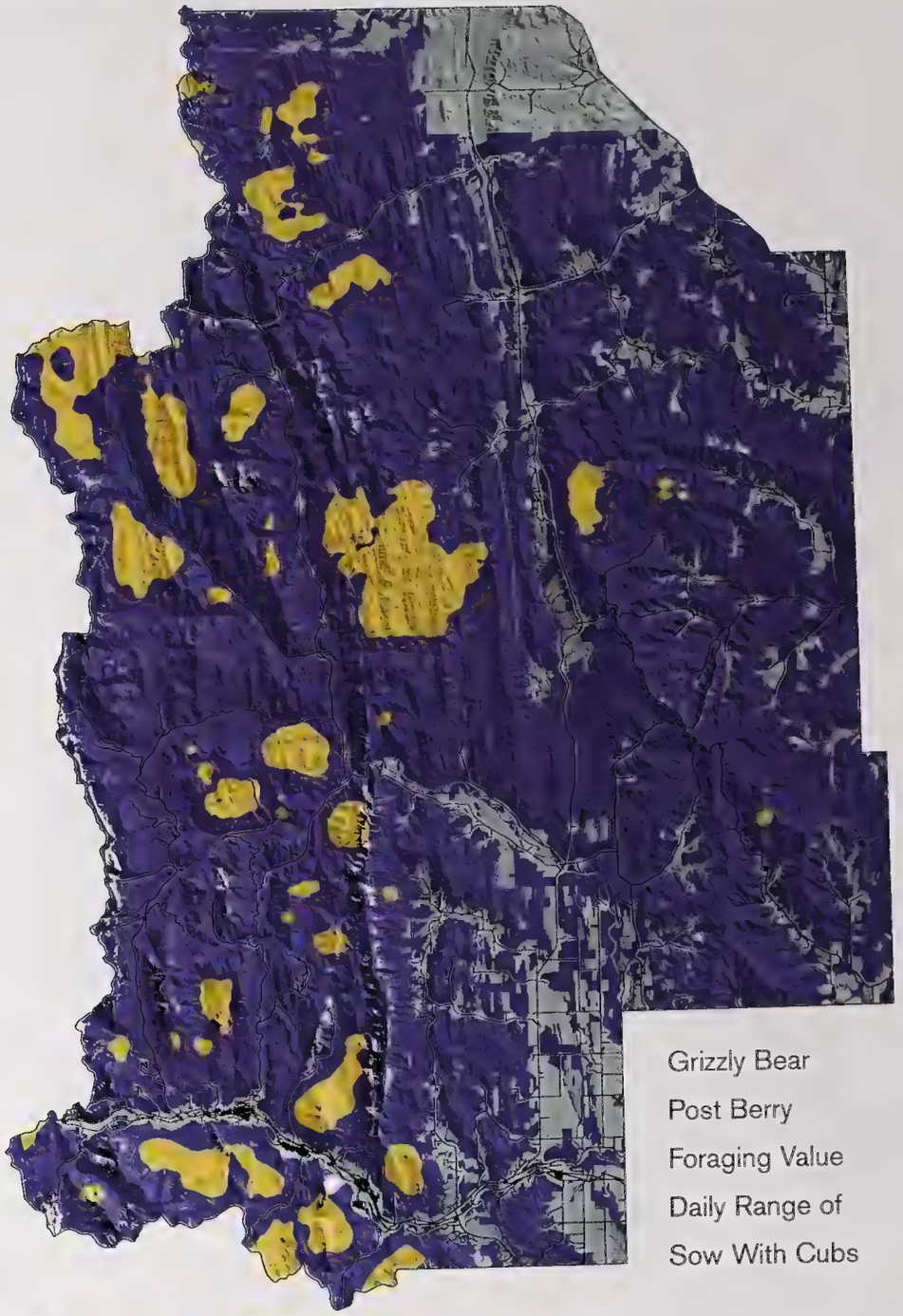


Grizzly Bear
Post Berry
Foraging Value
Daily Range of
Sow With Cubs

Lowest Moderate Highest

Fibre 50

Effective Habitat

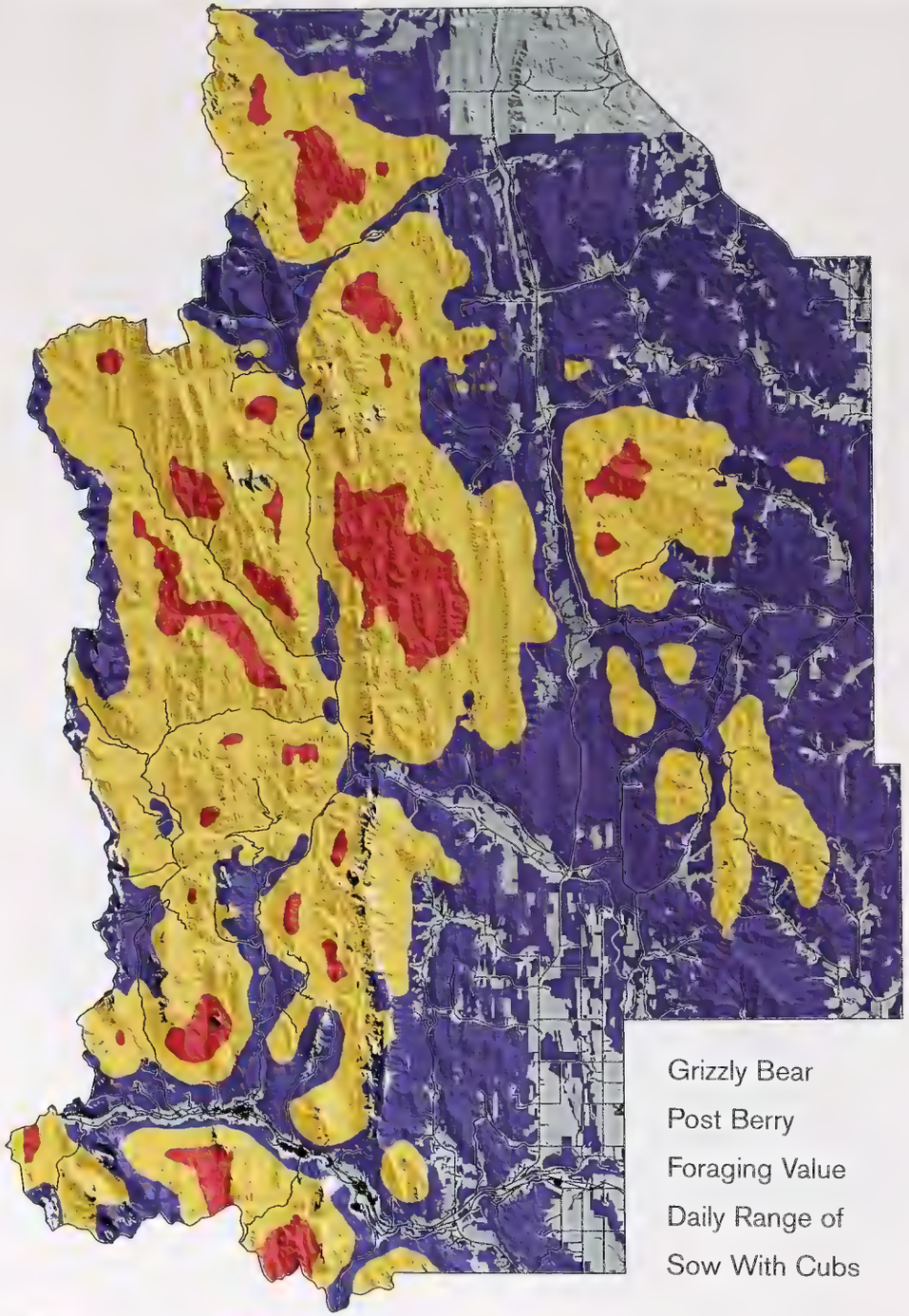


Grizzly Bear
Post Berry
Foraging Value
Daily Range of
Sow With Cubs

Lowest Moderate Highest

Preservation 20

Effective Habitat

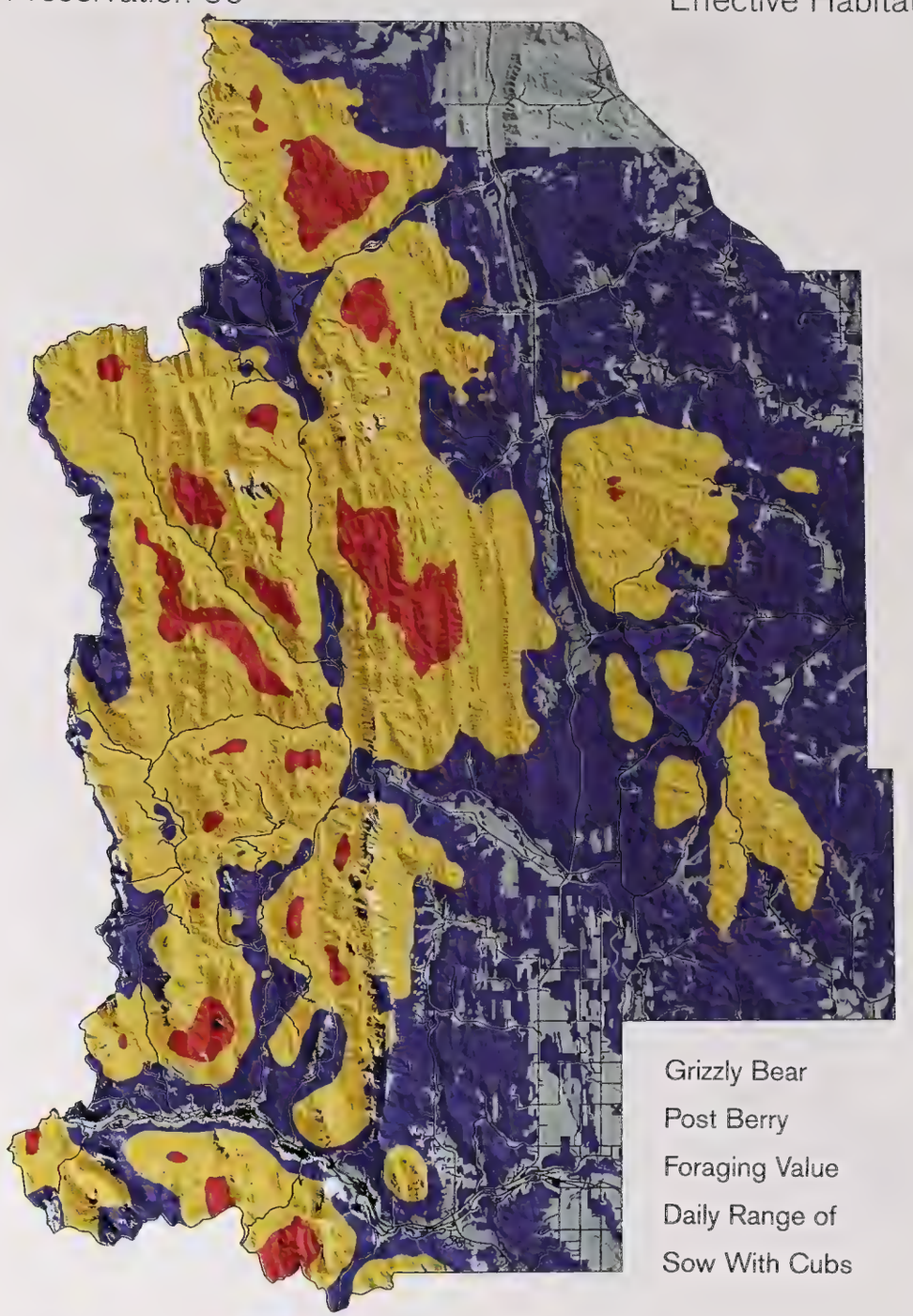


Grizzly Bear
Post Berry
Foraging Value
Daily Range of
Sow With Cubs

Lowest Moderate Highest

Preservation 50

Effective Habitat

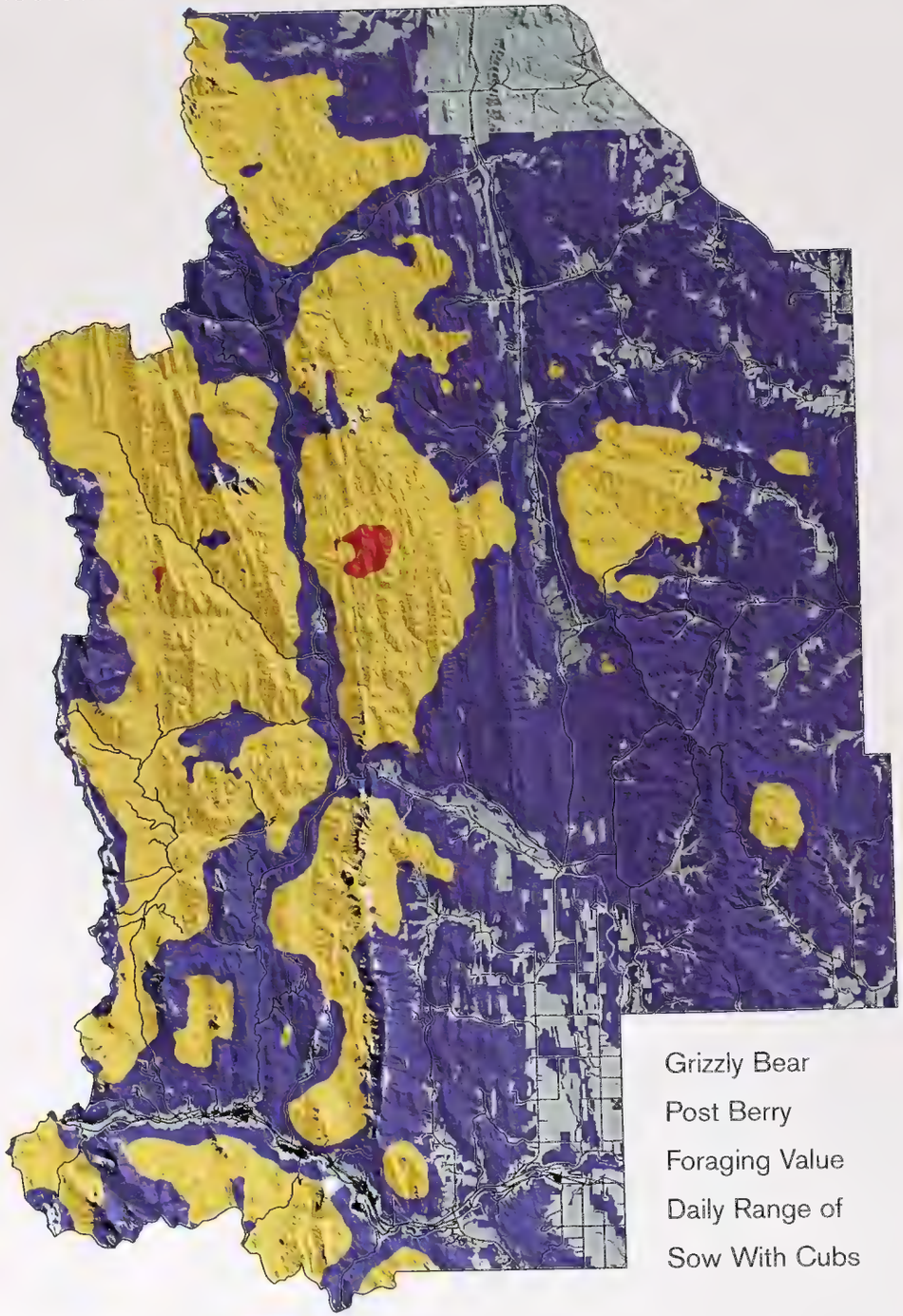


Grizzly Bear
Post Berry
Foraging Value
Daily Range of
Sow With Cubs

Lowest Moderate Highest

Recreation 20

Effective Habitat

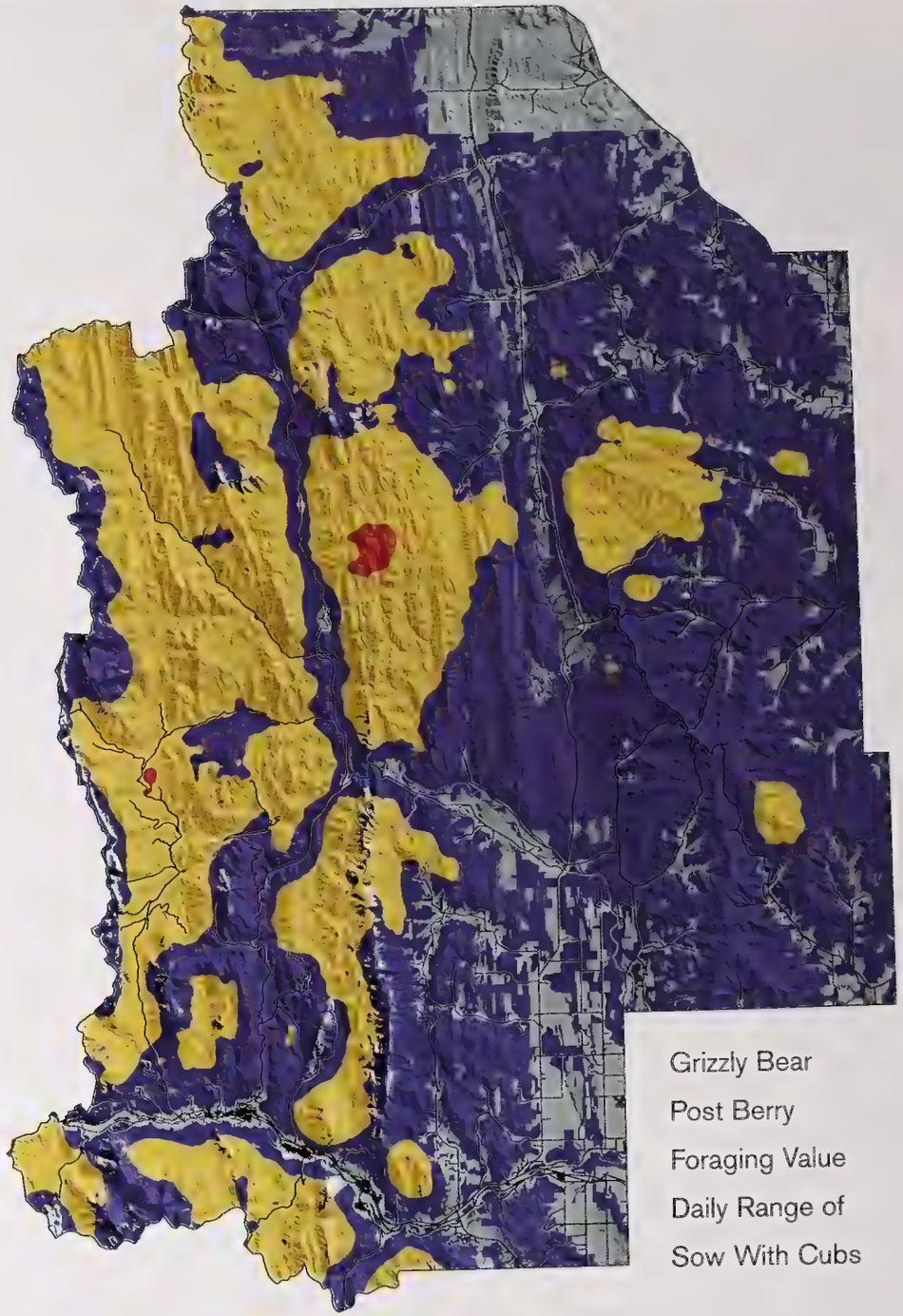


Grizzly Bear
Post Berry
Foraging Value
Daily Range of
Sow With Cubs

Lowest Moderate Highest

Recreation 50

Effective Habitat



Grizzly Bear
Post Berry
Foraging Value
Daily Range of
Sow With Cubs

Lowest Moderate Highest

4.1.1.2. ELK
(Cervus elaphus)
Potential Winter Habitat Model

Elk have been selected for modelling as they are important species from both a consumptive and non–consumptive viewpoint. The study area contains some of the best elk habitat in the province. Models have been developed for the following seasons: Summer; May 1 to November 30, and Winter; December 1 to April 30. Winter habitat is seen as limiting and is presented here.

The elk analysis has 3 major subcomponents (refer to diagram); summer foraging habitat (both potential and effective), winter foraging habitat (both potential and effective) and mapping of expert confirmed, heavily used, winter range, calving and migration routes. At present, there are no model calibration efforts underway other than comparison of the expert based habitat mapping with model outputs. The main winter model components (refer to diagram) are:

1. rating of the inherent forage value of ecosite phases based upon primary productivity, elk preference and the winter severity of the various natural subregions and aspects
2. potential winter forage value based upon modification of the inherent forage value by proximity to winter hiding cover
3. effective winter forage value based upon potential forage value and proximity to various types of human access and land uses

INHERENT WINTER FORAGE VALUE

All ecosite phases were assigned an inherent elk winter food value based upon ratings of ecosite phases for forage production (kg/ha) and elk palatability.

POTENTIAL WINTER FORAGE VALUE

The potential elk winter forage value map is the product of primary production in kg/ha x the preference modifier x the winter severity coefficient x the suitability index for distance from winter cover.

Winter Severity

The production values are further reduced by a winter severity coefficient. The concept of winter severity as used in the model derives from considerations of aspect and natural subregion.

Winter Cover

The concept of thermal cover has been subsumed by simplifying the definition of cover used by the winter model; cover is considered to be any forest type at least 5 meters in height and with a C or D density. The minimum patch size for winter cover is 4 ha. Within 500 m of cover, the SI value is considered to be 1.0 dropping to zero at 1,500 m in a straight line relationship.

HUMAN INFLUENCE ON HABITAT EFFECTIVENESS

The potential forage values are modified by the negative effect of human influences. Cumulative human influences are treated similarly in both the summer and winter models.

Access

Access (roads, trails, etc.) alter the effectiveness of elk habitat predominantly through disturbance and hunting pressure. This portion of the model classifies land use features and identifies zones and intensity of influence. The effects of the various uses are cumulative and the suitability index (SI) values are multiplied. Habitat effectiveness is calculated for both summer and winter range using the suitability indexes.

For the purposes of this model, access has been classified into three categories:

Access Type A – All Weather: paved roads, gravel two lane, gravel one lane, main rail lines
Access Type B – Good Weather: unimproved roads, truck trails, spur rail lines
Access Type C – Backcountry: trail/cutline and utility corridor

In the case of Type A, suitability of habitat is reduced within 500 meters of the road. Beyond 500 meters, potential habitat value is retained. In the case of Type B access, habitat value is reduced within 500 meters of the road, but never by more than 70%. Again, beyond 500 meters, the potential values are retained. Type C access reduces value within a distance of 500 meters, but the habitat value is only reduced by a maximum of 20%.

Other Land Use Zones of Influence

Other human uses have both a zone and a degree of influence on elk habitat. The following are the types of use included in Land Use Type A:

- Human Habitation/Ranch House
- Wellsite
- Gas Plant
- Campground

Effective Elk Winter Forage Formula

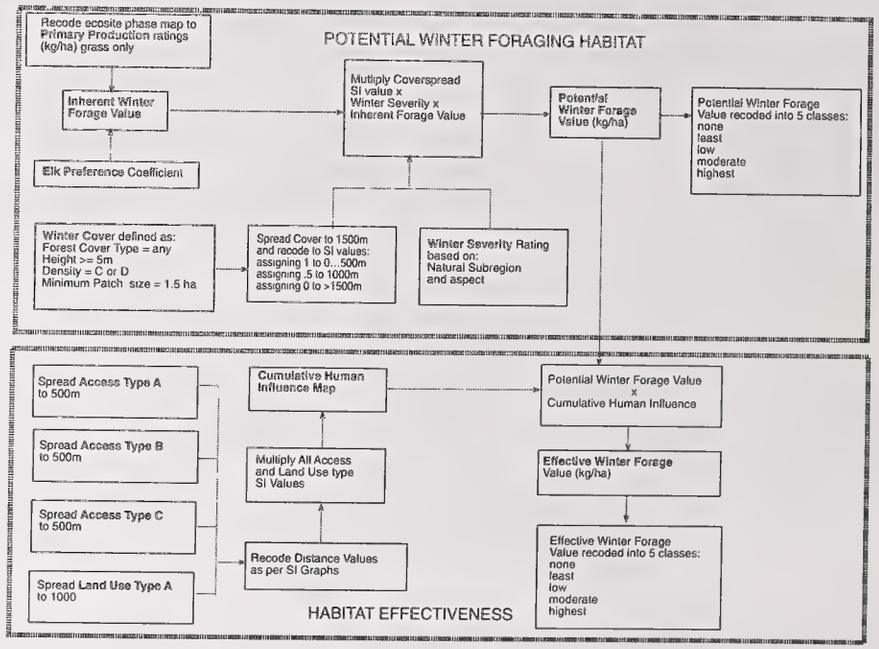
Elk preference, winter severity, as well as the proximity to winter cover and various access and land use types, modify the potential winter forage. The formula for the effective elk winter forage value is therefore:

$$EWFV = PPw * SI_1 * SI_2 * SI_3 * SI_4 * SI_5 * SI_6 * SI_7 * SI_8$$

where:

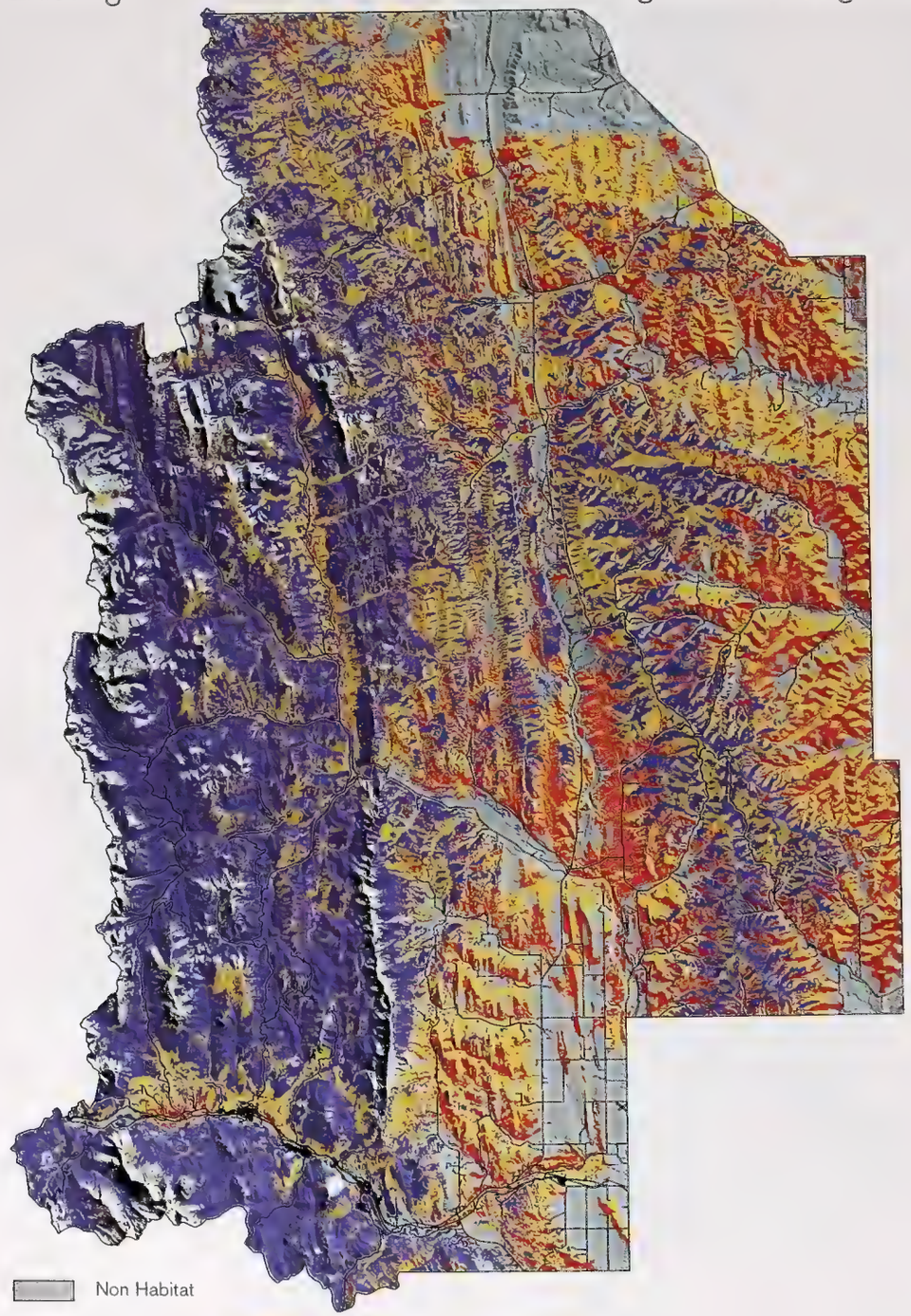
EWFV = Effective Elk Winter Forage Value
PPw = Estimated Primary Production of Ecosite Phase (grass component only)
SI_1 = Ecosite Phase Elk Preference Coefficient (0...1)
SI_2 = Coefficient for Winter Severity of Natural Subregion (0...1)
SI_3 = Coefficient for Winter Severity of Aspect (0.2...1)
SI_4 = Coefficient for Proximity to Cover (0...1)
SI_5 = Coefficient for Proximity to Access Type A (0...1)
SI_6 = Coefficient for Proximity to Access Type B (0.3...1)
SI_7 = Coefficient for Proximity to Access Type C (0.8...1)
SI_8 = Coefficient for Proximity to Land Use Type A (0.2...1)

Figure 59. Elk Potential Habitat Model Structure


Recode ecosite phase map to Primary Production ratings (kg/ha) grass only
POTENTIAL WINTER FORAGING HABITAT
Inherent Winter Forage Value
Multiply Coverspread SI value x Winter Severity x Inherent Forage Value
Potential Winter Forage Value (kg/ha)
Potential Winter Forage Value recoded into 5 classes: none least low moderate highest
Elk Preference Coefficient
Winter Cover defined as: Forest Cover Type = any Height >= 5m Density = C or D Minimum Patch size = 1.5 ha
Spread Cover to 1500m and recode to SI values: assigning 1 to 0...500m assigning .5 to 1000m assigning 0 to >1500m
Winter Severity Rating based on: Natural Subregion and aspect
Spread Access Type A to 500m
Spread Access Type B to 500m
Spread Access Type C to 500m
Spread Land Use Type A to 1000
Cumulative Human Influence Map
Multiply All Access and Land Use type SI Values
Recode Distance Values as per SI Graphs
Potential Winter Forage Value x Cumulative Human Influence
Effective Winter Forage Value (kg/ha)
Effective Winter Forage Value recoded into 5 classes: none least low moderate highest
HABITAT EFFECTIVENESS

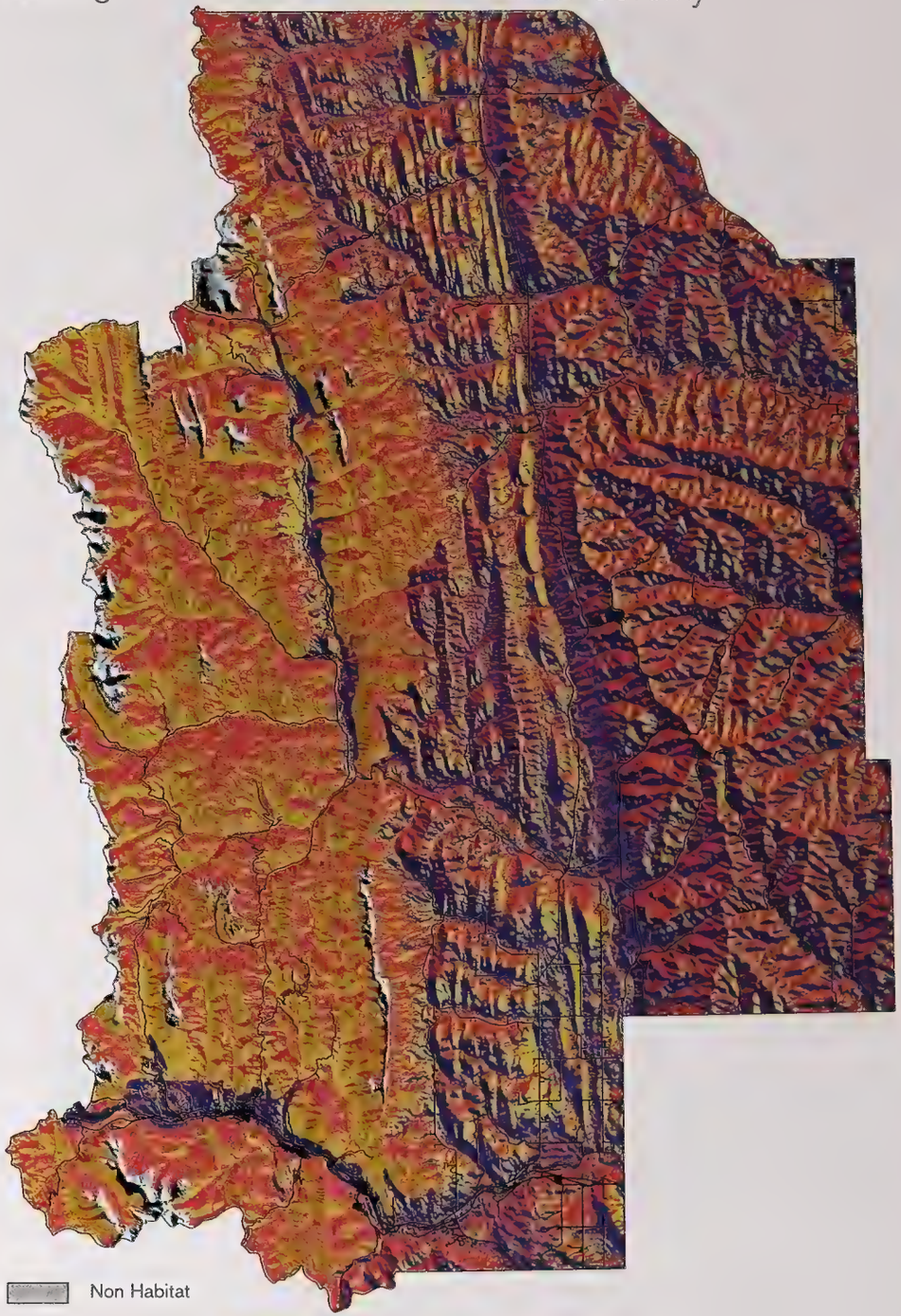
Existing

Winter Vegetation Forage Value



Existing

Winter Severity



Effective Elk Winter Forage Value (cont'd.)

Winter severity based upon natural subregion, aspect and elevation was calculated and is used in the winter elk habitat model. Primary production ratings for the various ecosite phases were calculated for elk and included in the food value importance rating.

In order to help calibrate the model, known elk habitat was mapped using expert opinion and ecological land units from the ecological land classification coverage draped over LANDSAT TM imagery. The following areas were identified:

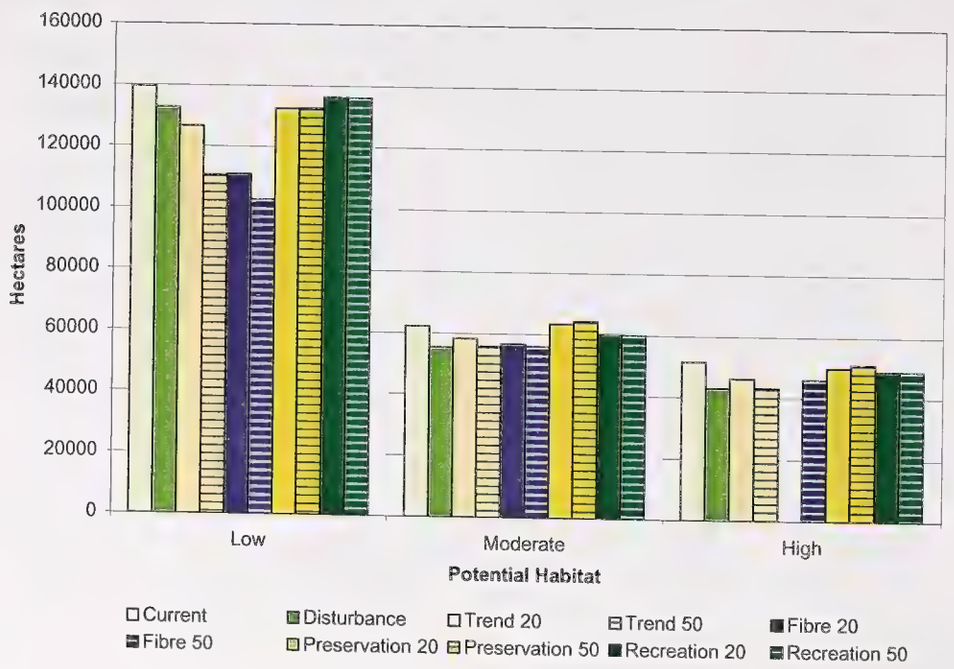
- Elk Calving Areas
- Migration Routes
- Winter Habitat
- Winter Habitat, Calving Areas

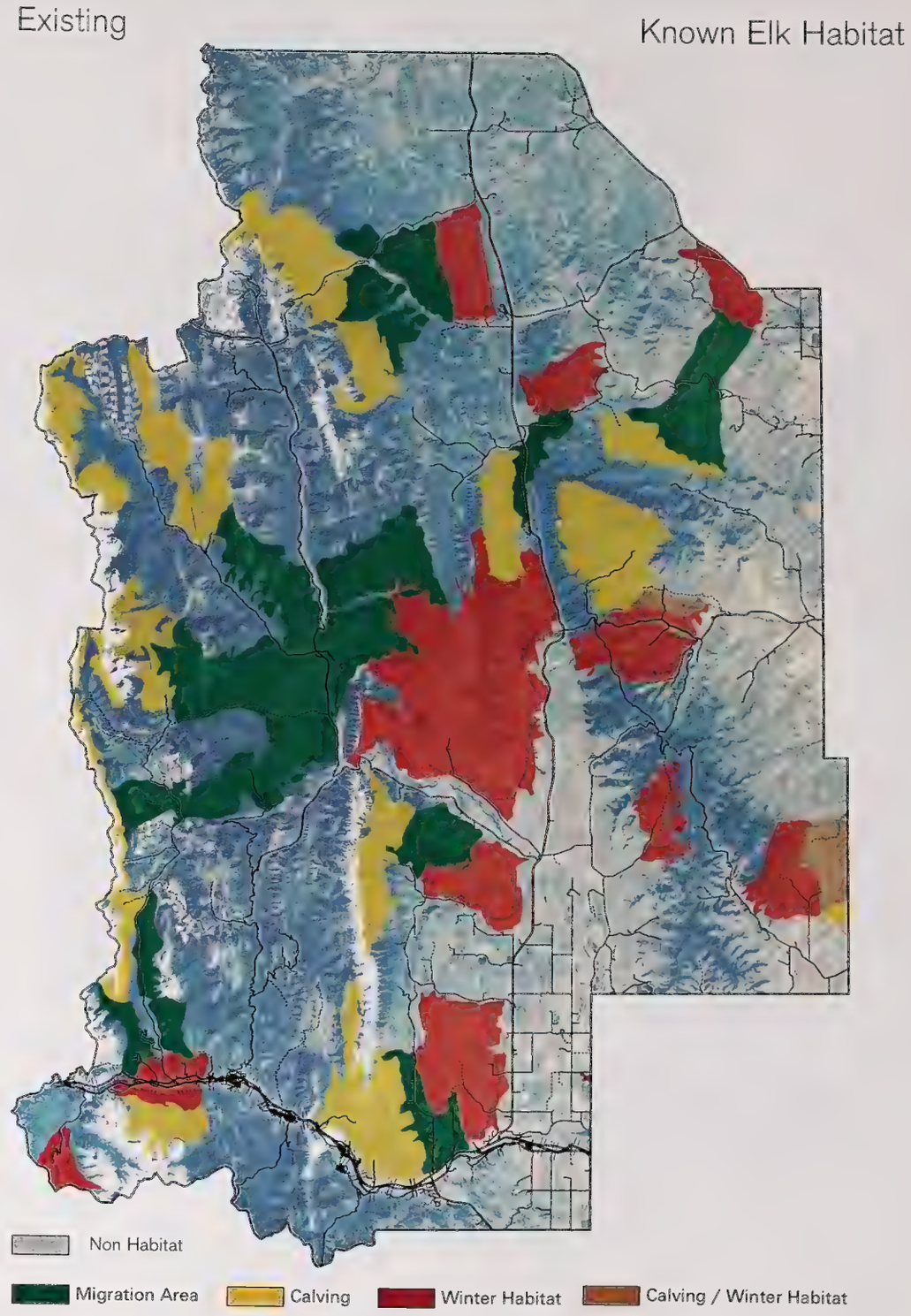
These large patches of habitat represent the general use of the area and differ from the modelling results in several ways. The computer model is based on 25 m x 25 m pixels and the total characteristics of the individual pixels in terms of vegetation, aspect, and proximity to roadways, etc. The expert opinion, on the other hand, is based upon aerial surveys and ground observations and indicates the general use of a larger area. In addition, the computer model indicates potential habitat and does not consider other management interventions such as depredation control or increased hunting pressure.

Despite these differences, there is considerable coincidence between areas that are known to be important winter habitat and that generated by the model. Model results for the existing conditions in the Whaleback indicate high value habitat throughout the area. Similarly, the model is consistent with important wintering areas in the Crowsnest Pass, Chapel Rock and Porcupine Hills Landscape Management Units. For location of management units, refer to page 11.

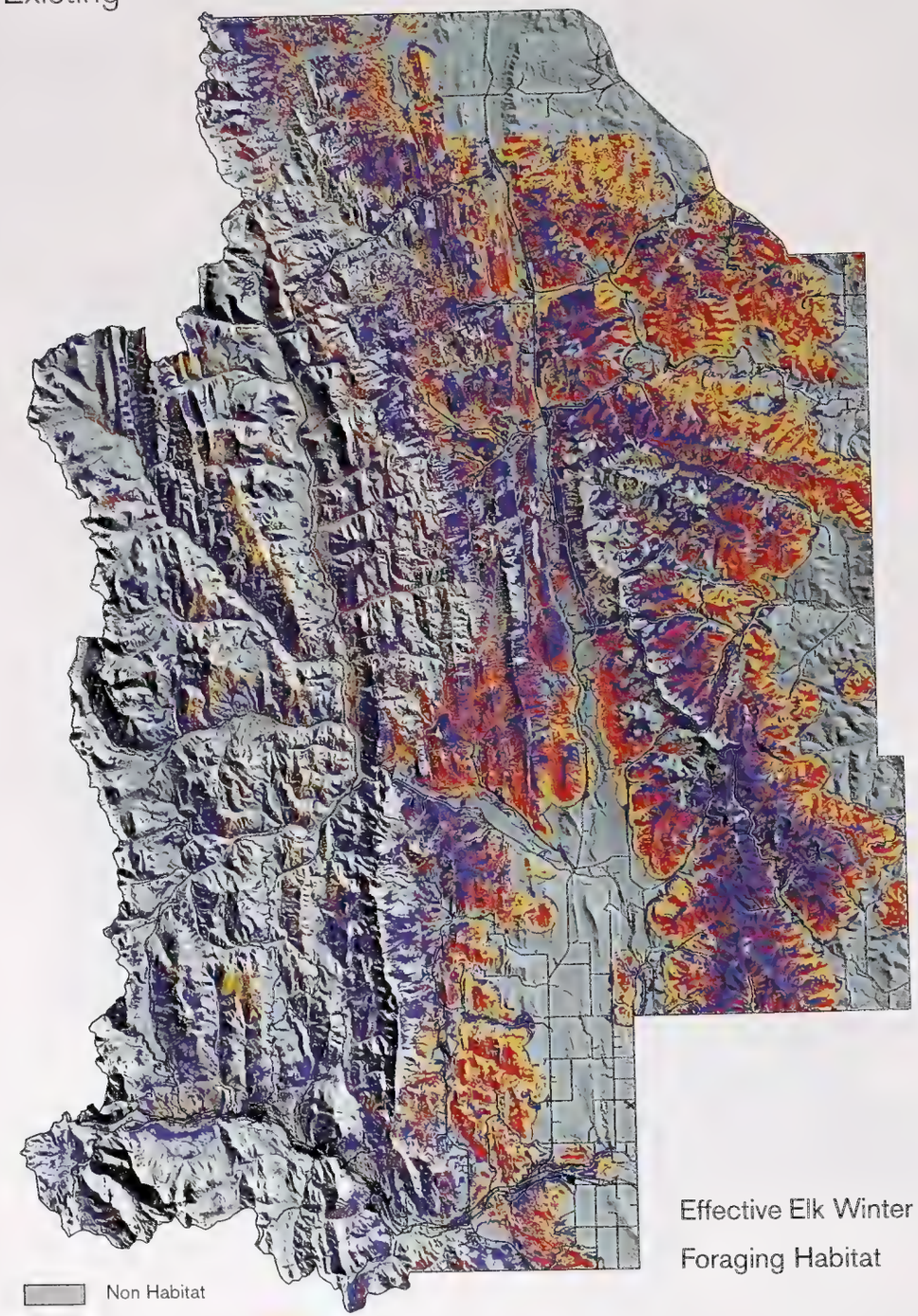
The results of the modelling indicate that, under all scenarios, moderate and high value elk habitat is maintained at or near existing levels. This is not surprising, as grasslands are not undergoing considerable change under the assumptions of the scenarios. Low value habitat decreases over time under the Trend and Fibre Scenarios while remaining near current levels under the Preservation and Recreation Scenarios. The amount of elk habitat in the area is not expected to be a limiting factor to elk management in the area. Rather, numbers are likely to be managed below maximum potential for other reasons, such as conflict with ranching interests in the area.

Figure 60. Elk Potential Habitat Value – Scenarios Comparison





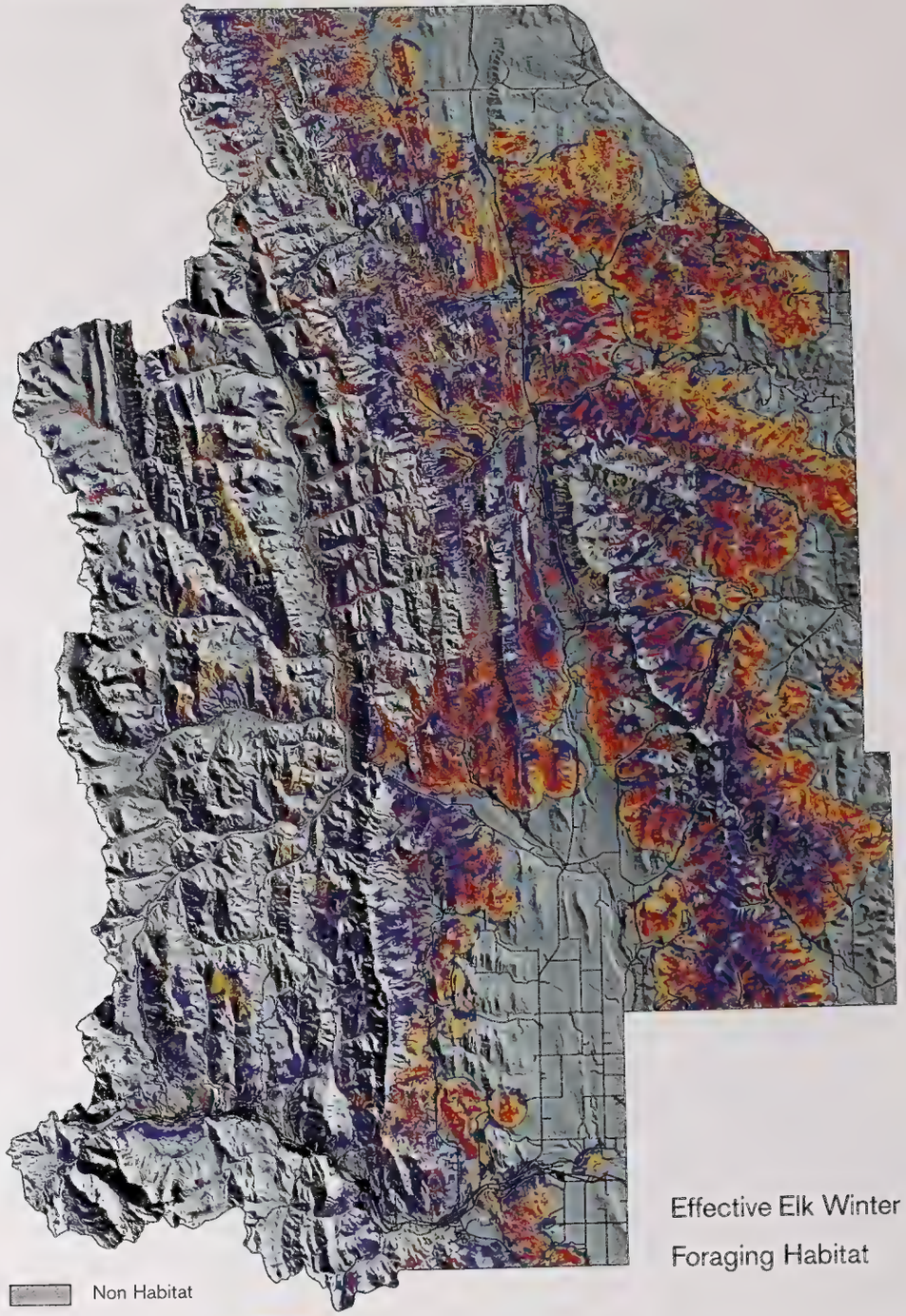
Existing



Effective Elk Winter
Foraging Habitat

Non Habitat
Lowest
Moderate
Highest

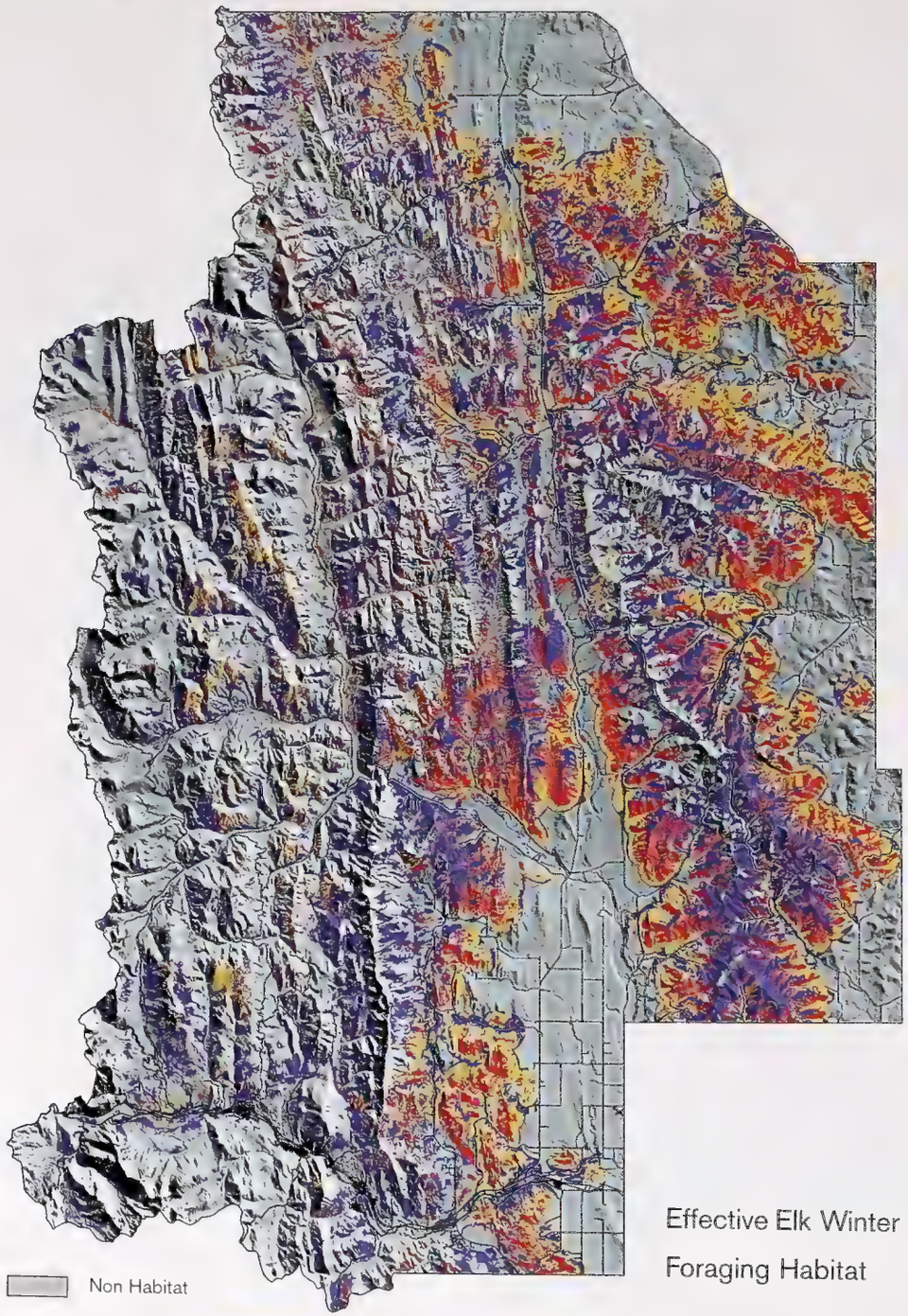
Disturbance



Effective Elk Winter
Foraging Habitat

Non Habitat
Lowest
Moderate
Highest

Trend 20



Effective Elk Winter
Foraging Habitat

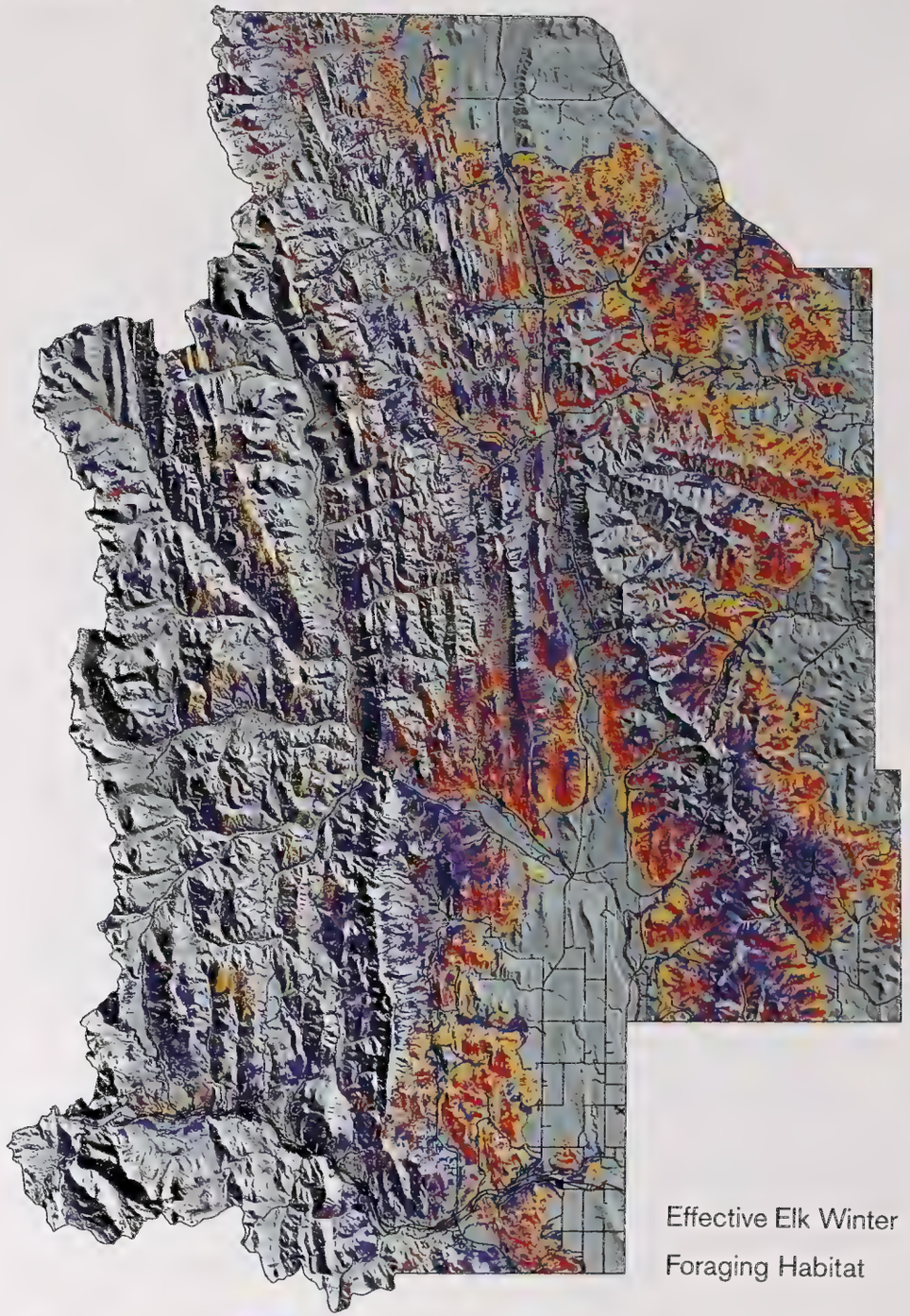
Non Habitat

Lowest

Moderate

Highest

Trend 50



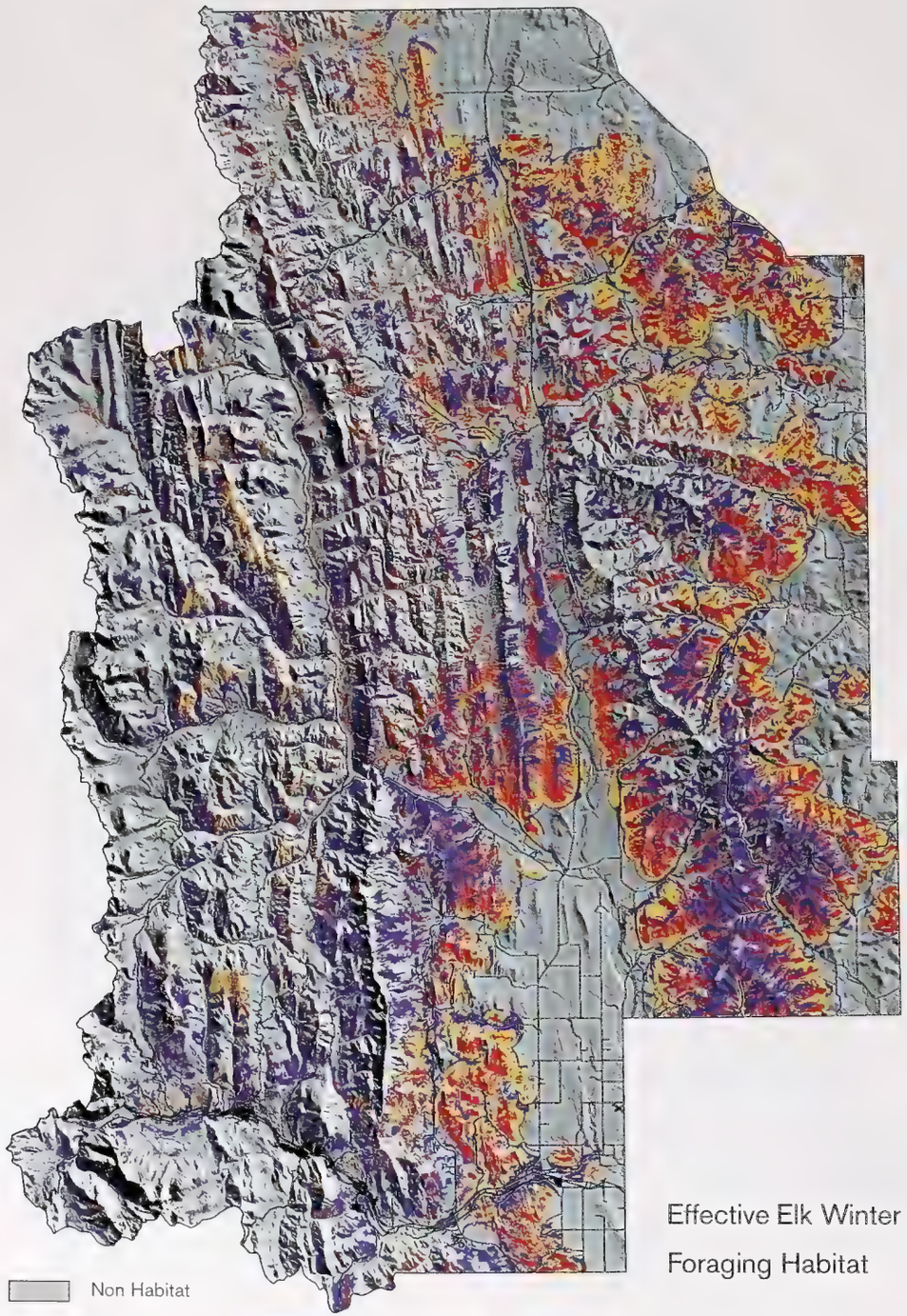
Effective Elk Winter
Foraging Habitat

Lowest

Moderate

Highest

Fibre 20



Effective Elk Winter
Foraging Habitat

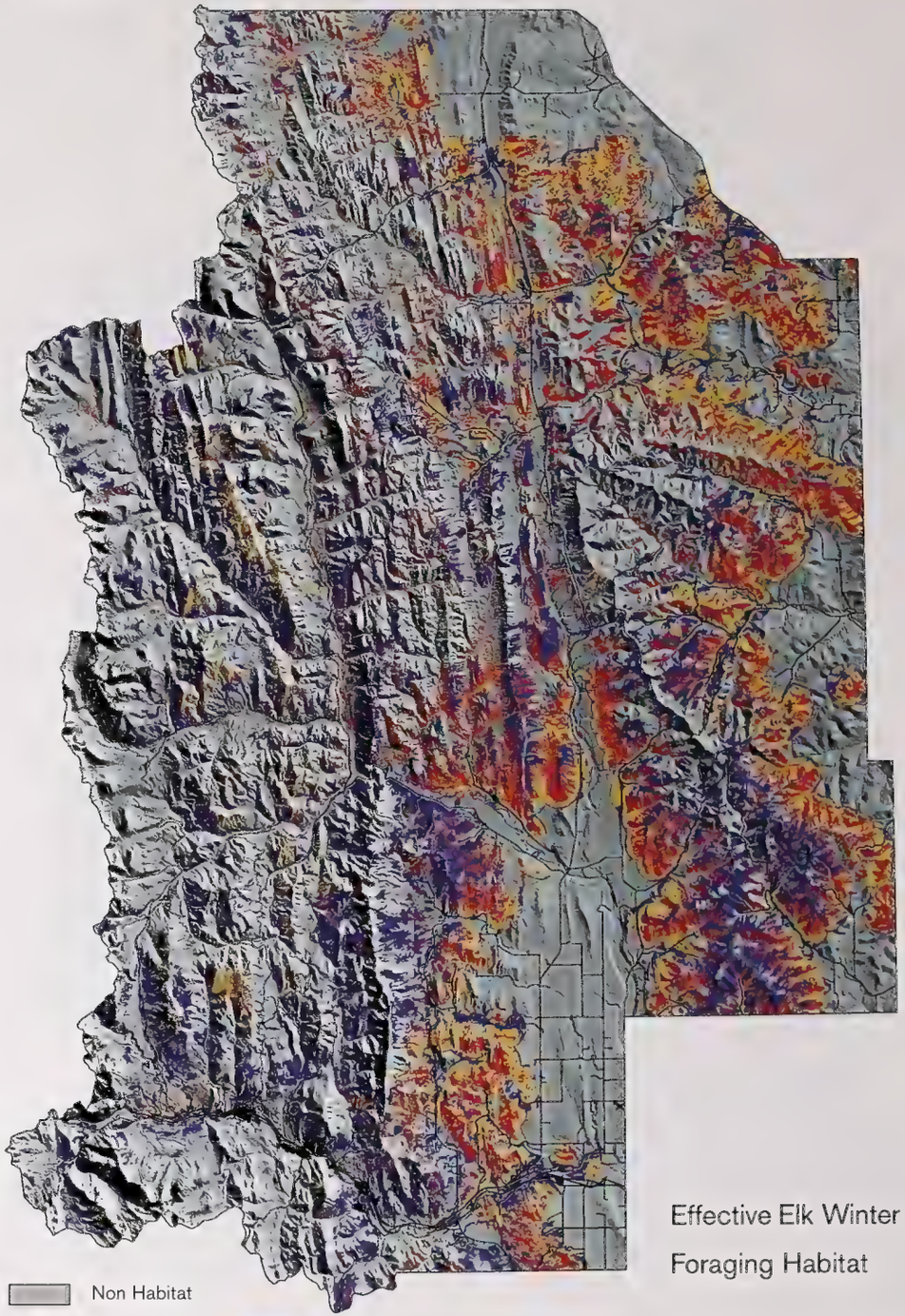
Non Habitat

Lowest

Moderate

Highest

Fibre 50



Effective Elk Winter
Foraging Habitat

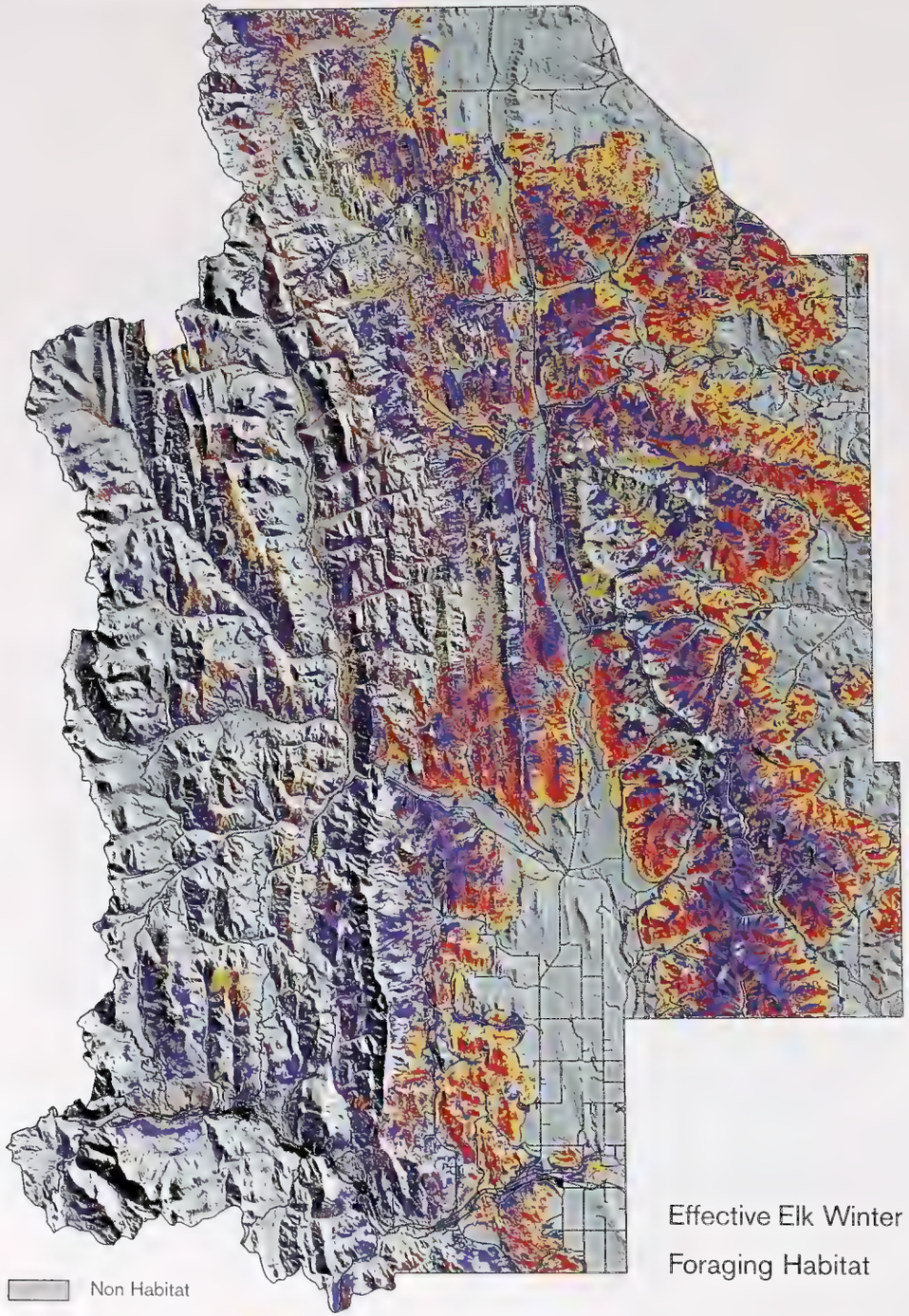
Non Habitat

Lowest

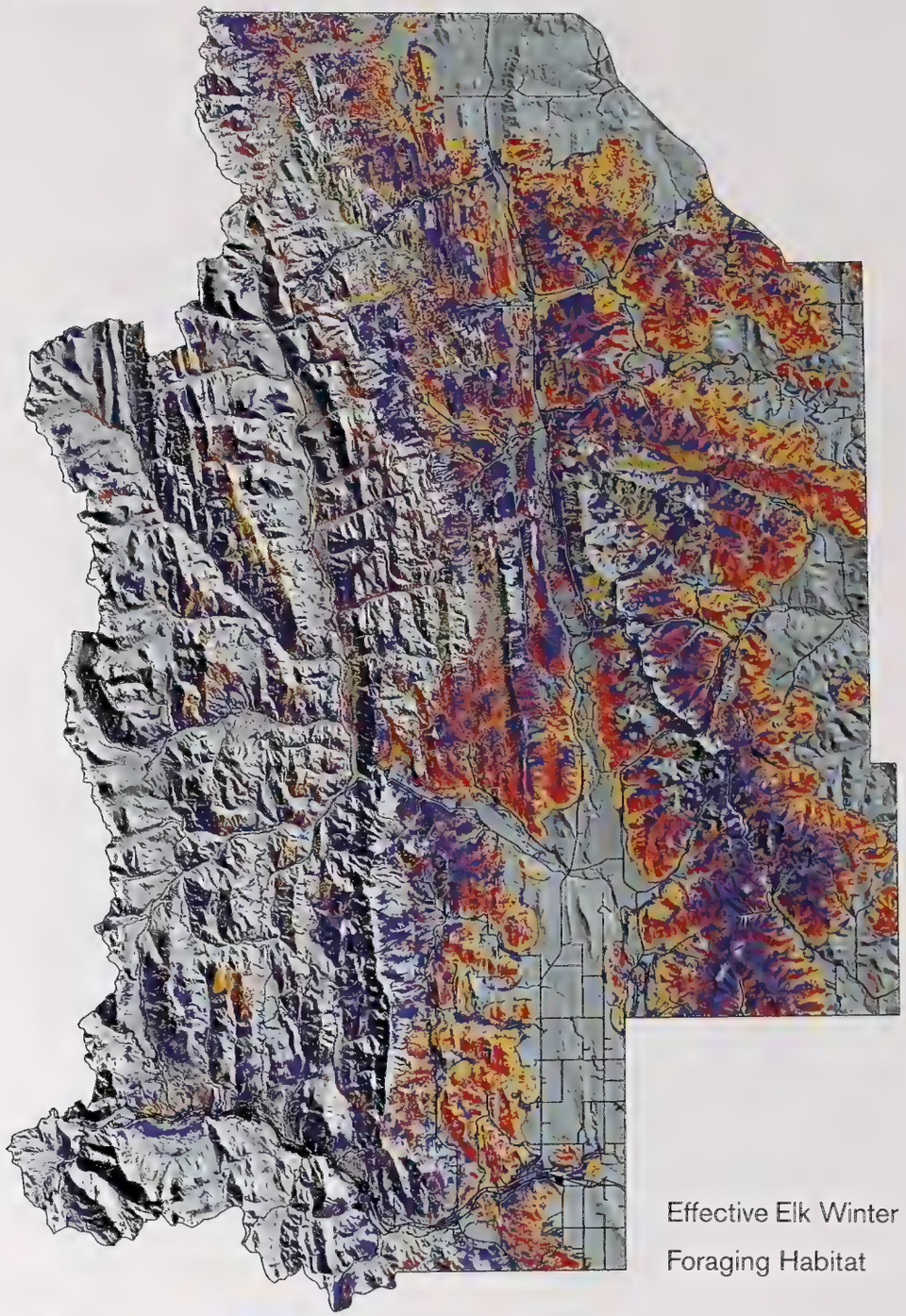
Moderate

Highest

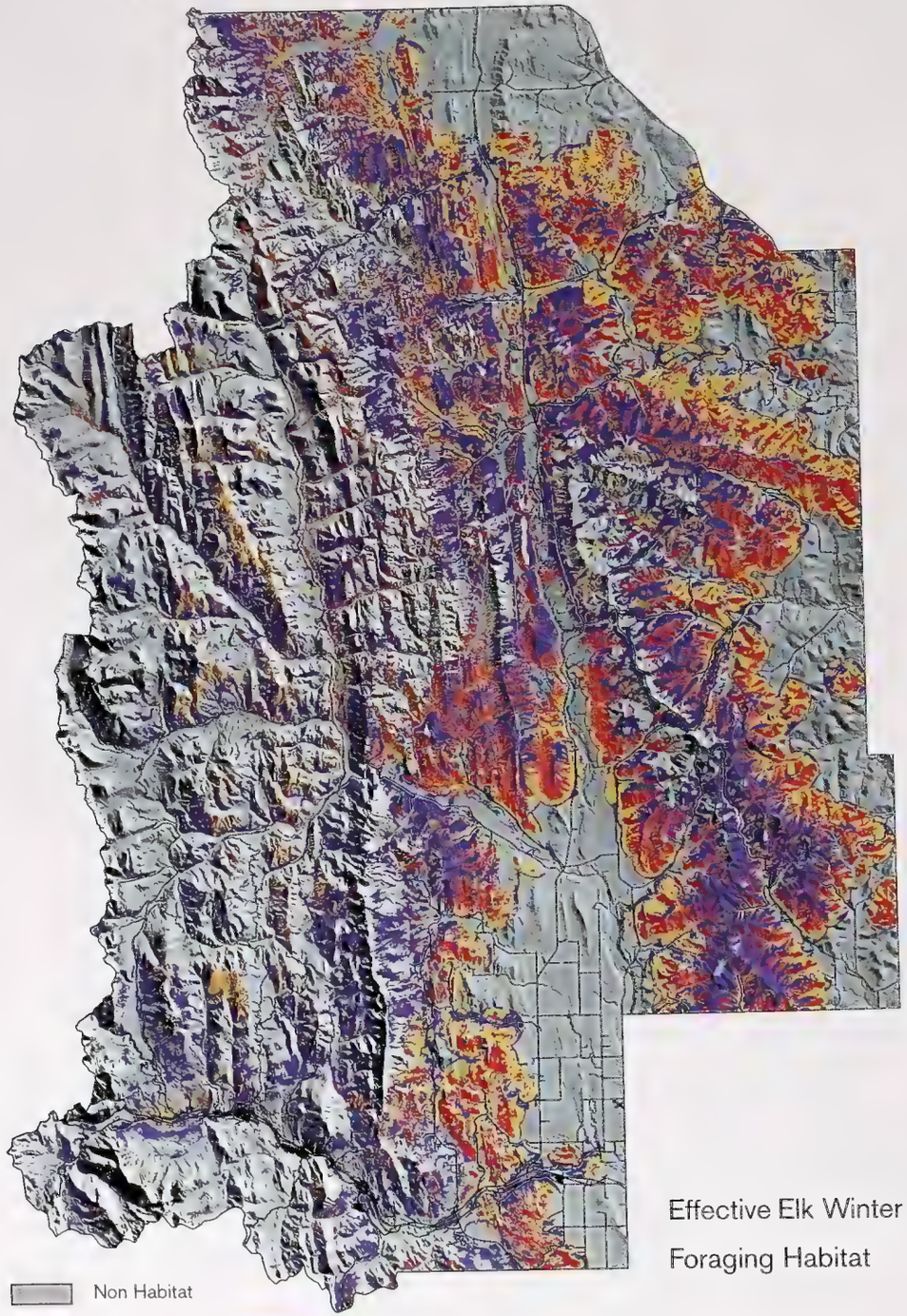
Preservation 20



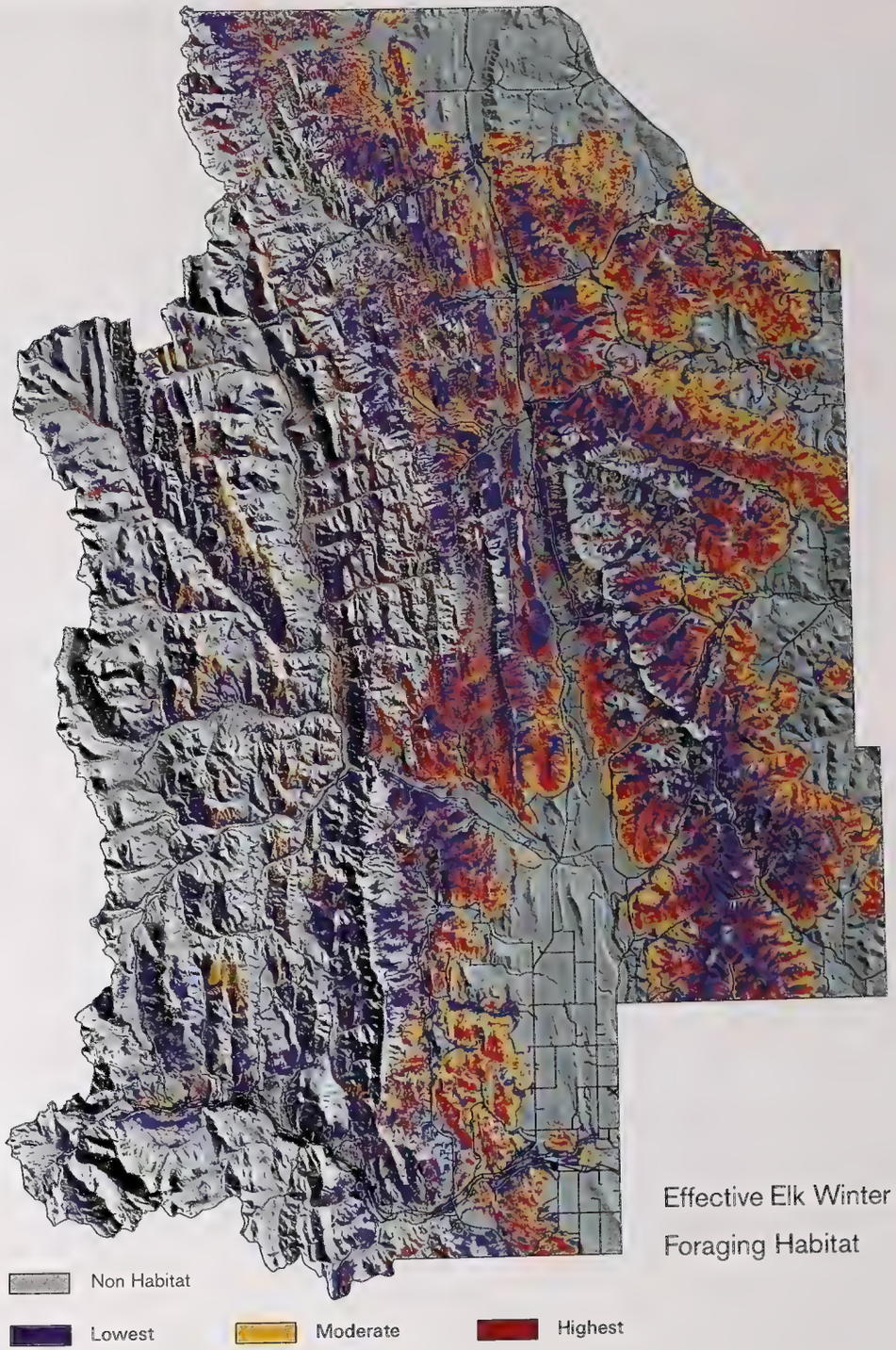
Preservation 50



Recreation 20



Recreation 50



4.1.1.3. MOOSE

(Alces alces)
Potential Winter Habitat Model

Moose are an important species in the area from both a consumptive and non–consumptive stand point. Valley bottoms, deciduous and mixed wood stands, coniferous thermal cover and shrub meadows are among the import habitats utilized by moose. The effectiveness of the habitat is impacted by proximity to various types of access and land uses as well as distance from acceptable cover. Winter habitat is seen as limiting and therefore has been the focus of the model.

Potential moose winter habitat has been modelled using the following major variables; shrub canopy closure, tree canopy closure, tree height, acceptable food species, distance from cover and distance from various types of access. The details of the models are found in the report on wildlife models.

The impacts of the scenarios are variable. The Trend reduces the quality of moose habitat primarily through increased access. There is a slight increase in low quality habitat with a corresponding decrease in moderate quality areas. High quality habitat remains close to existing conditions but degrades over time.

The Disturbance Scenario appears to have the worst effect on moose. This is primarily due to an initial decrease in shrub cover and vegetation palatability as well as a reduction in cover. This is expected to be a short–term impact and vegetation quality and cover conditions should rebound within 20 years.

The Fibre Scenario has a minor negative impact on moose primarily due to increased access. The Preservation Scenario has a significant positive impact on moose due to a reduction in access throughout the area. The area is high and moderate quality habitat increases by approximately 15%.

The Recreation Scenario maintains habitat at very close to existing conditions. A very slight increase in highest quality habitat is realized.

Figure 61. Area of Potential Winter Moose Habitat – All Scenarios

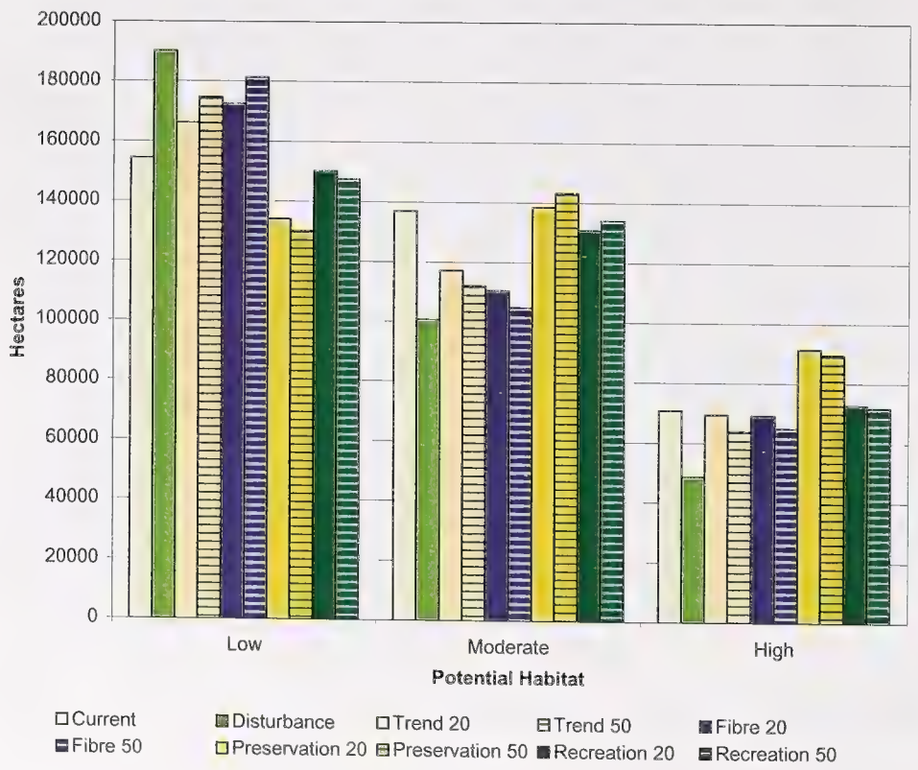
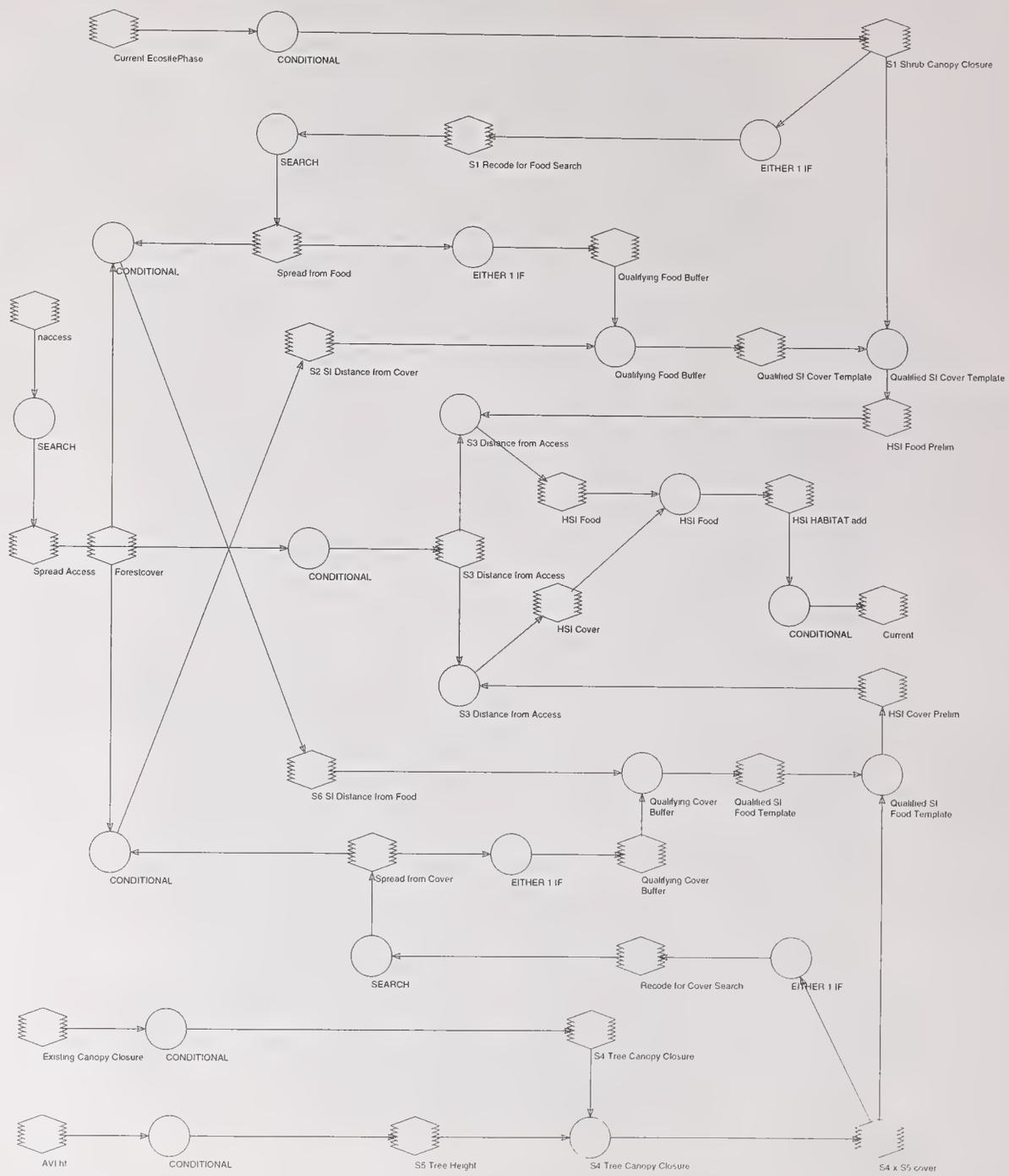
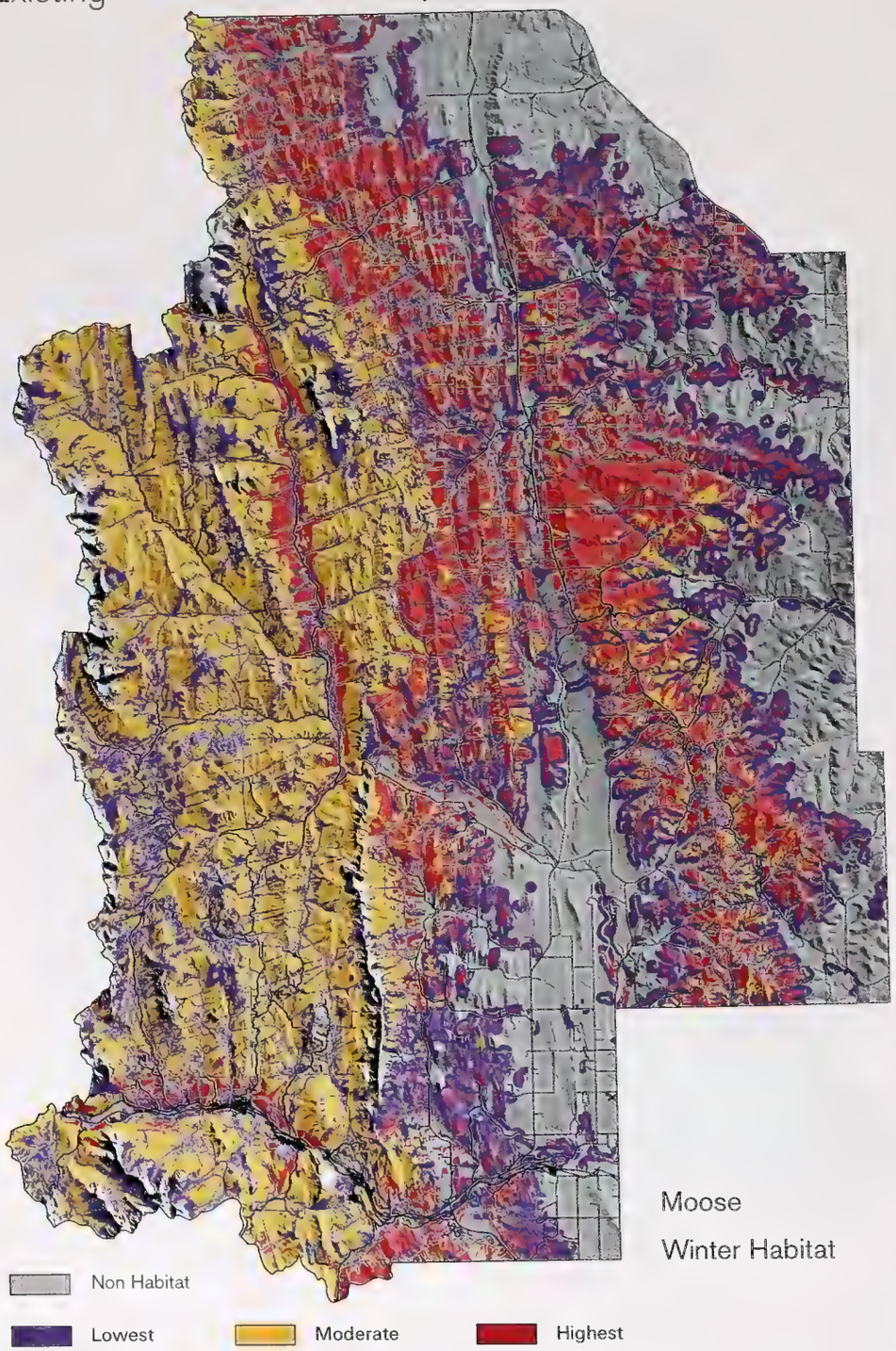


Figure 62. Potential Winter Moose Habitat Graphical Model

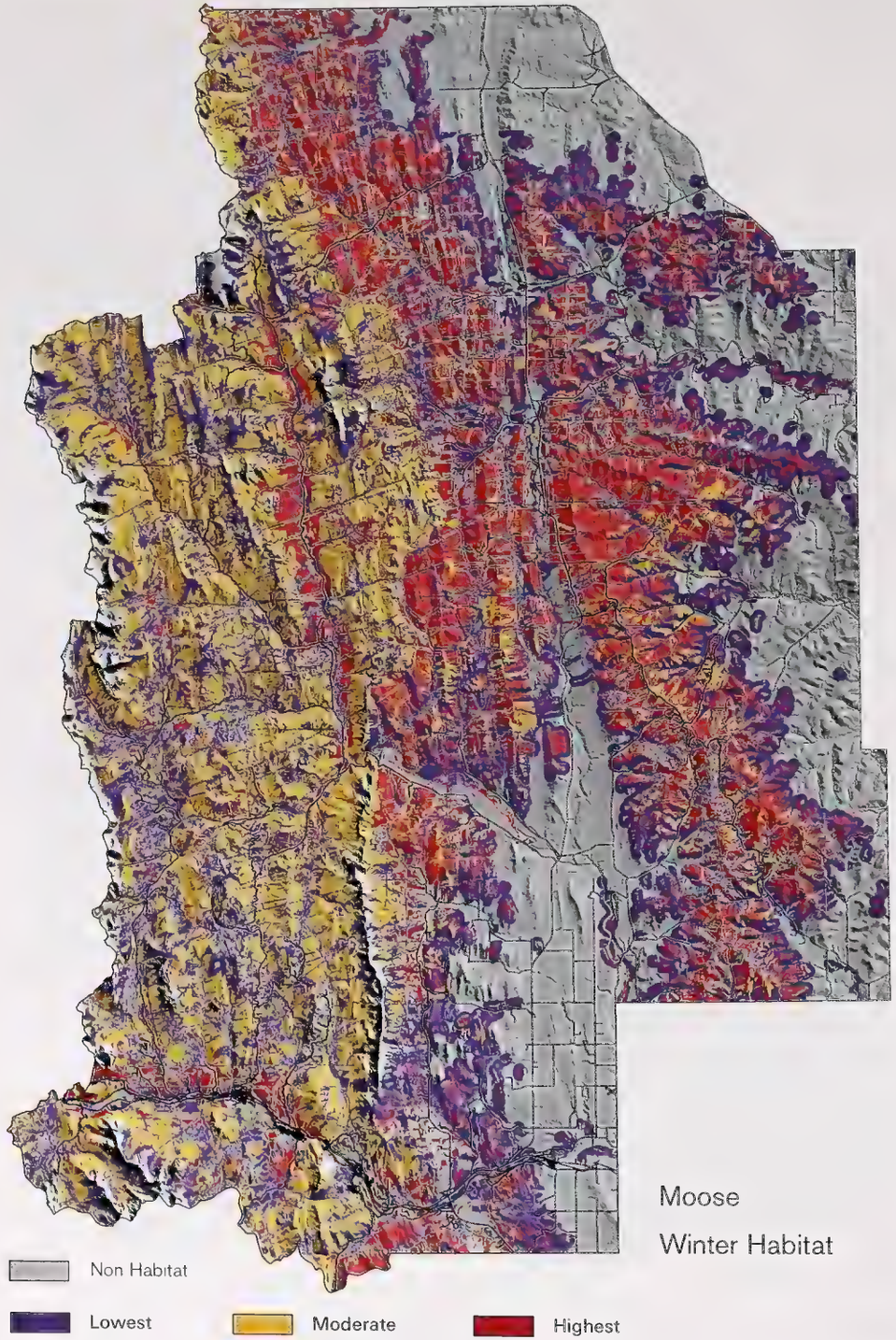


Existing



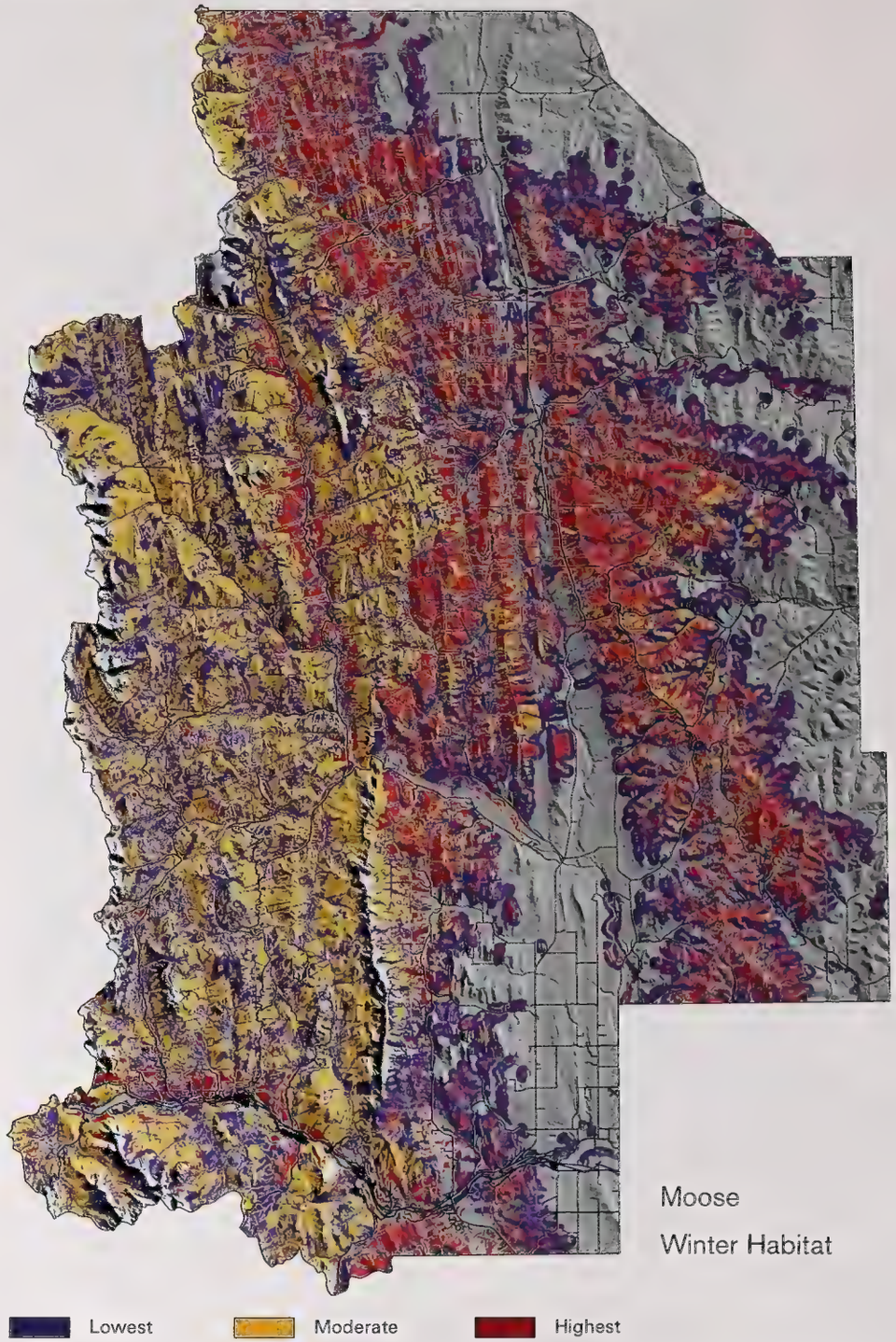
Disturbance

Trend 20



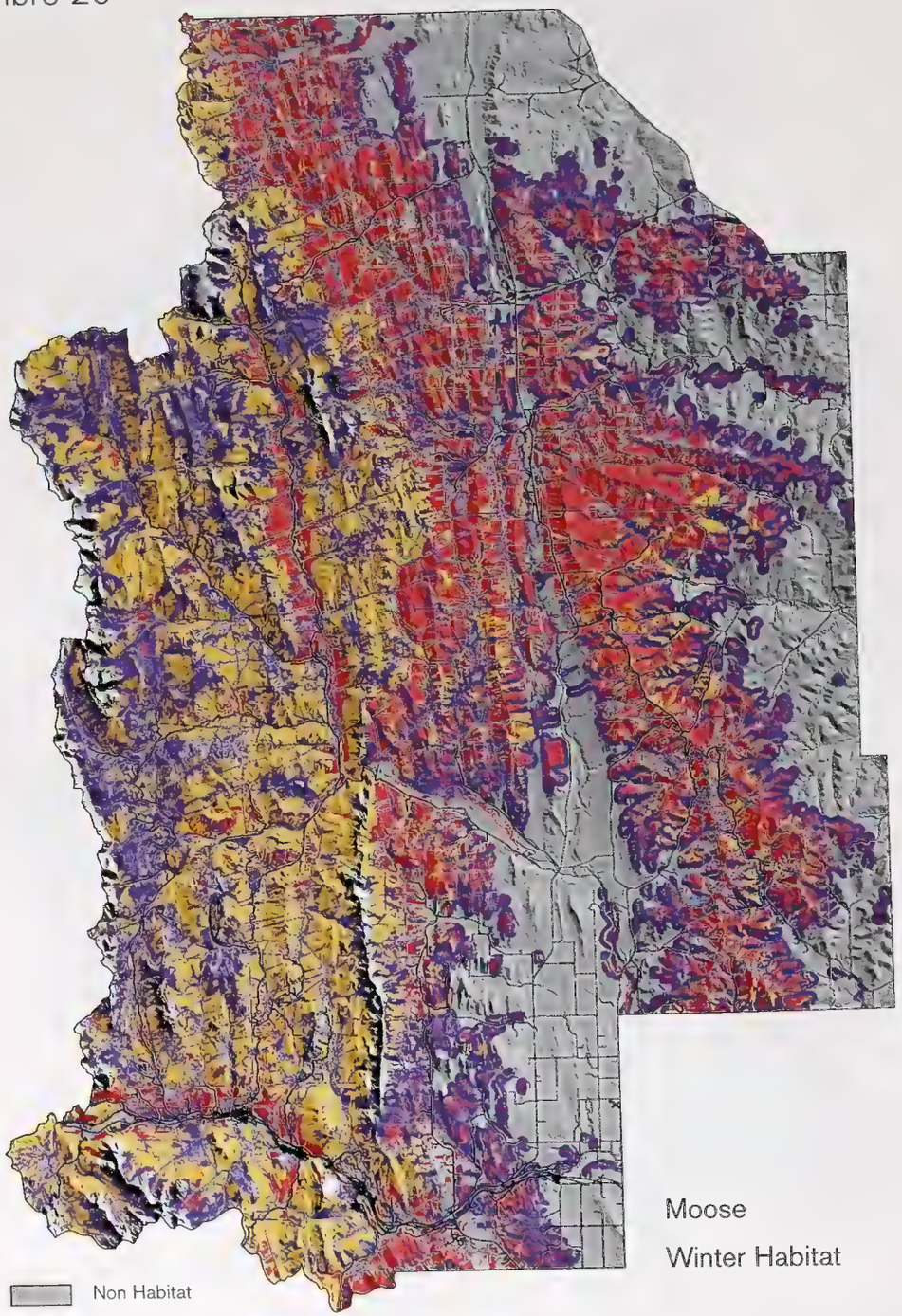
Moose
Winter Habitat

Trend 50

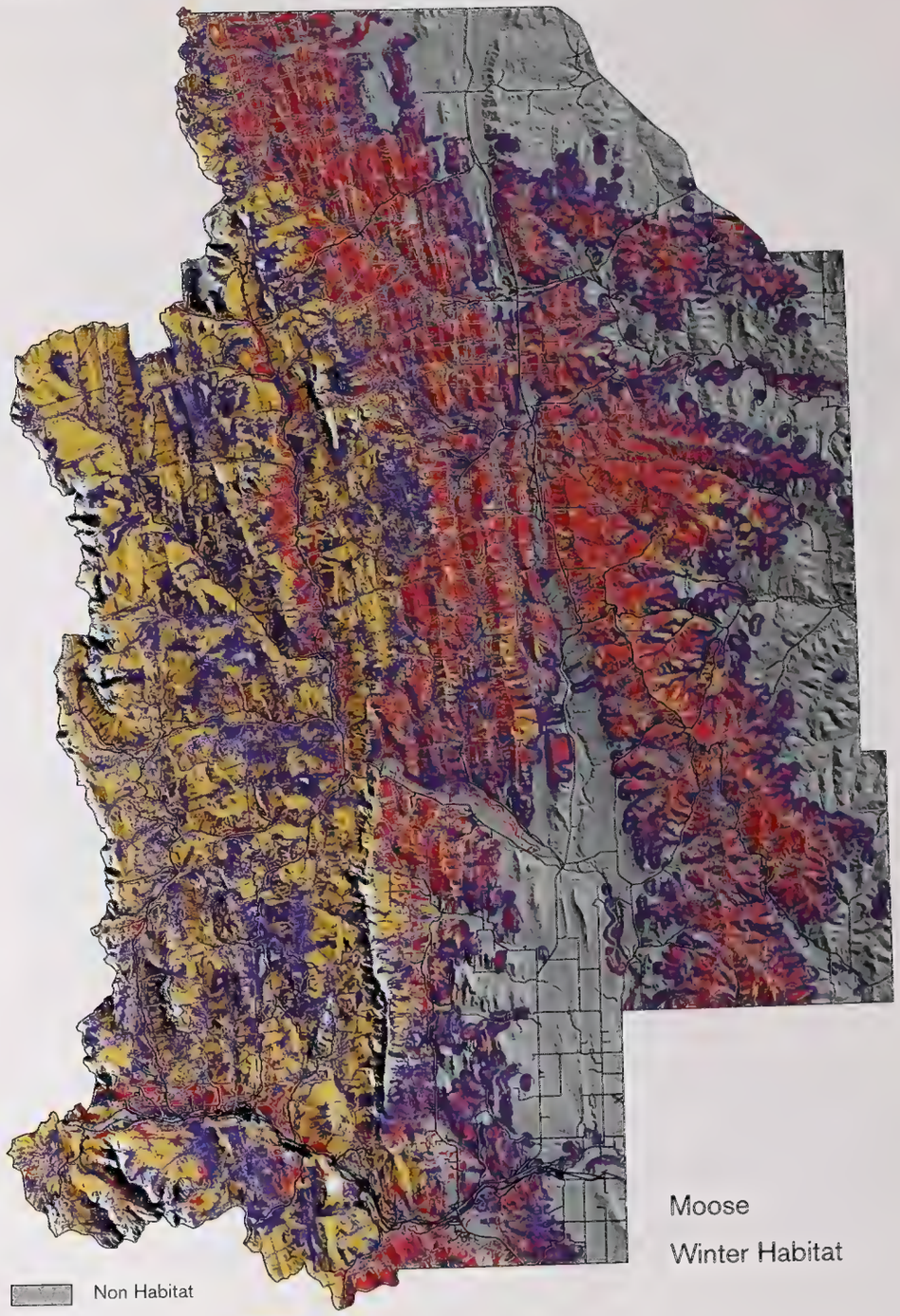


Moose
Winter Habitat

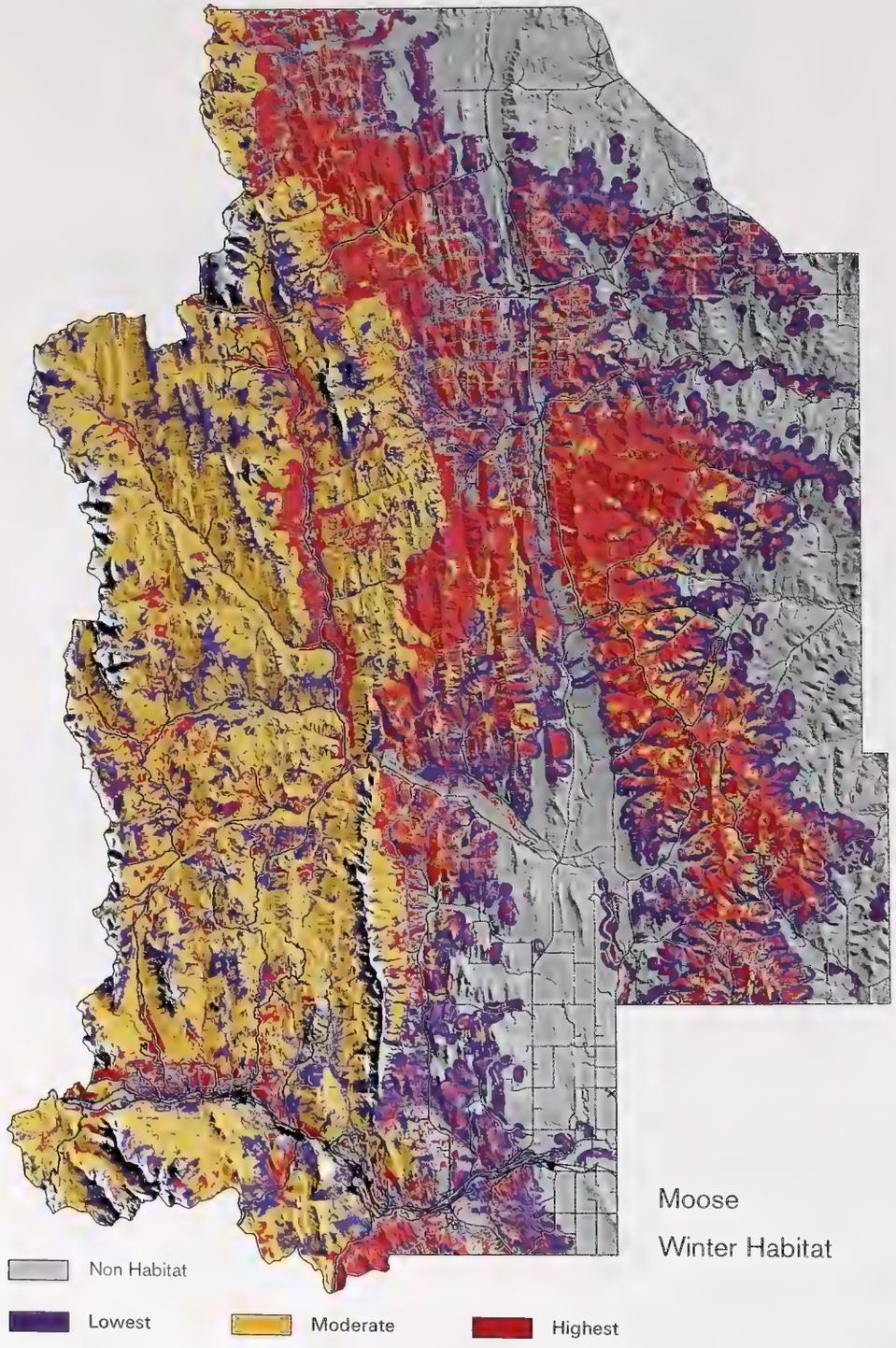
Fibre 20



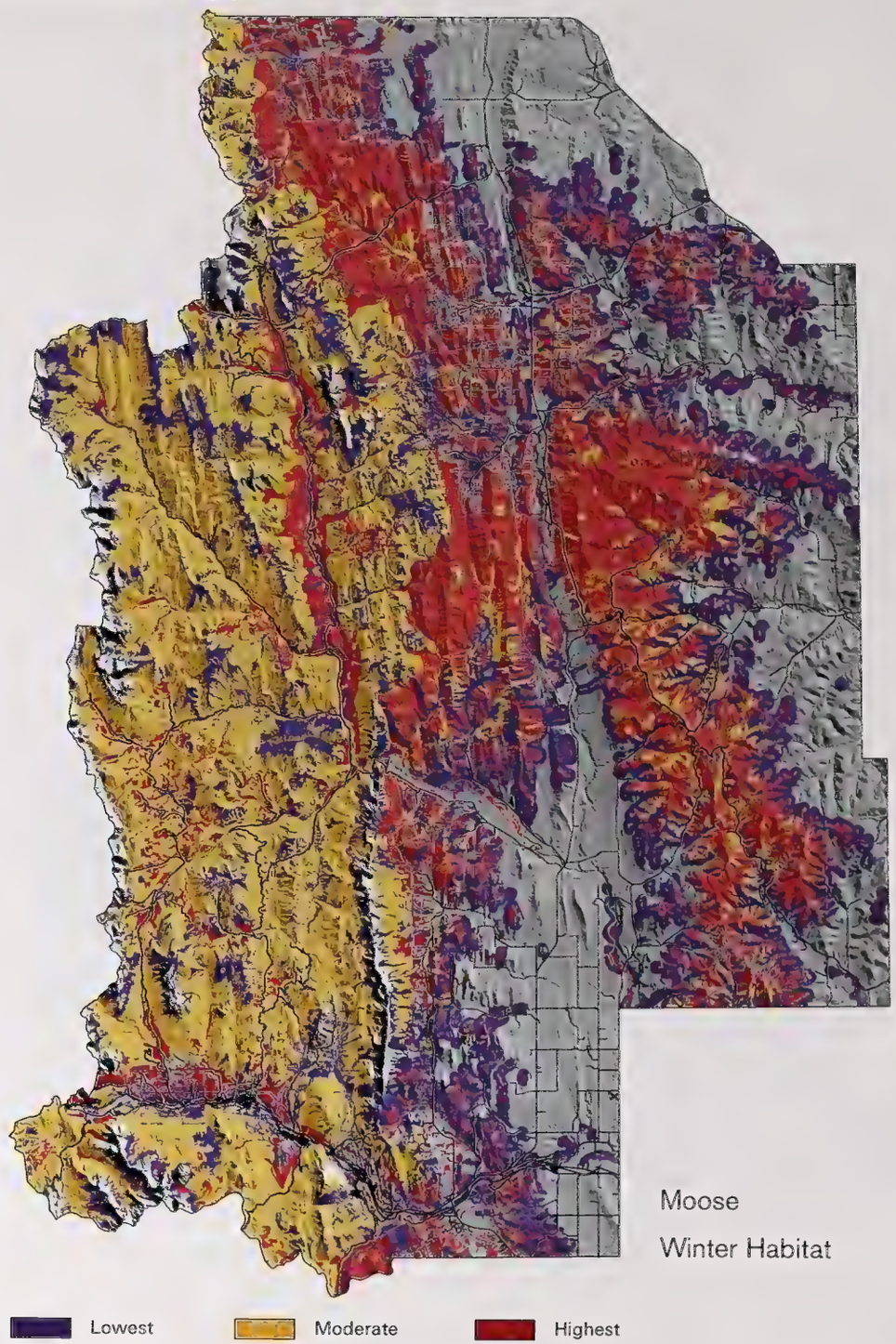
Fibre 50



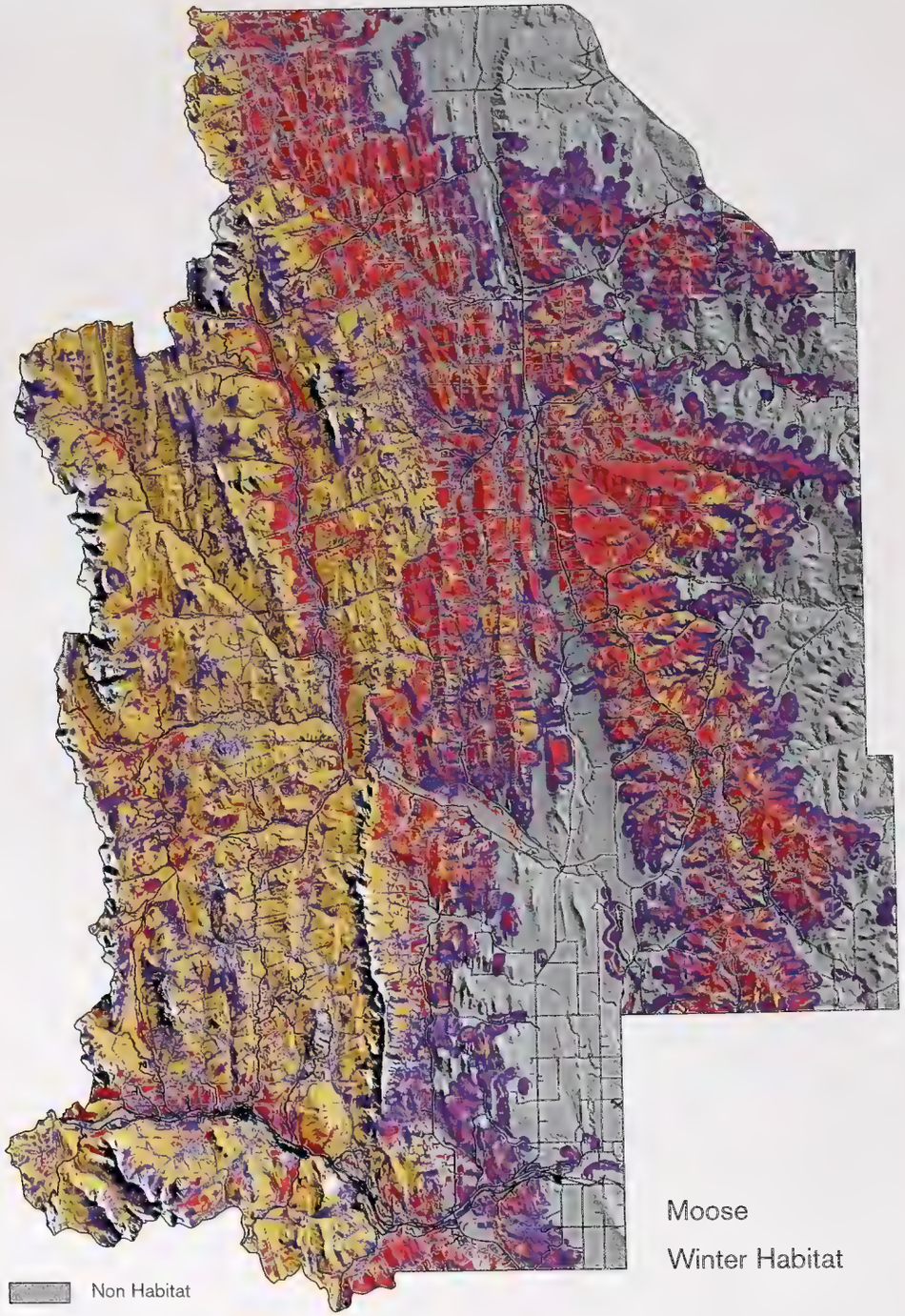
Preservation 20



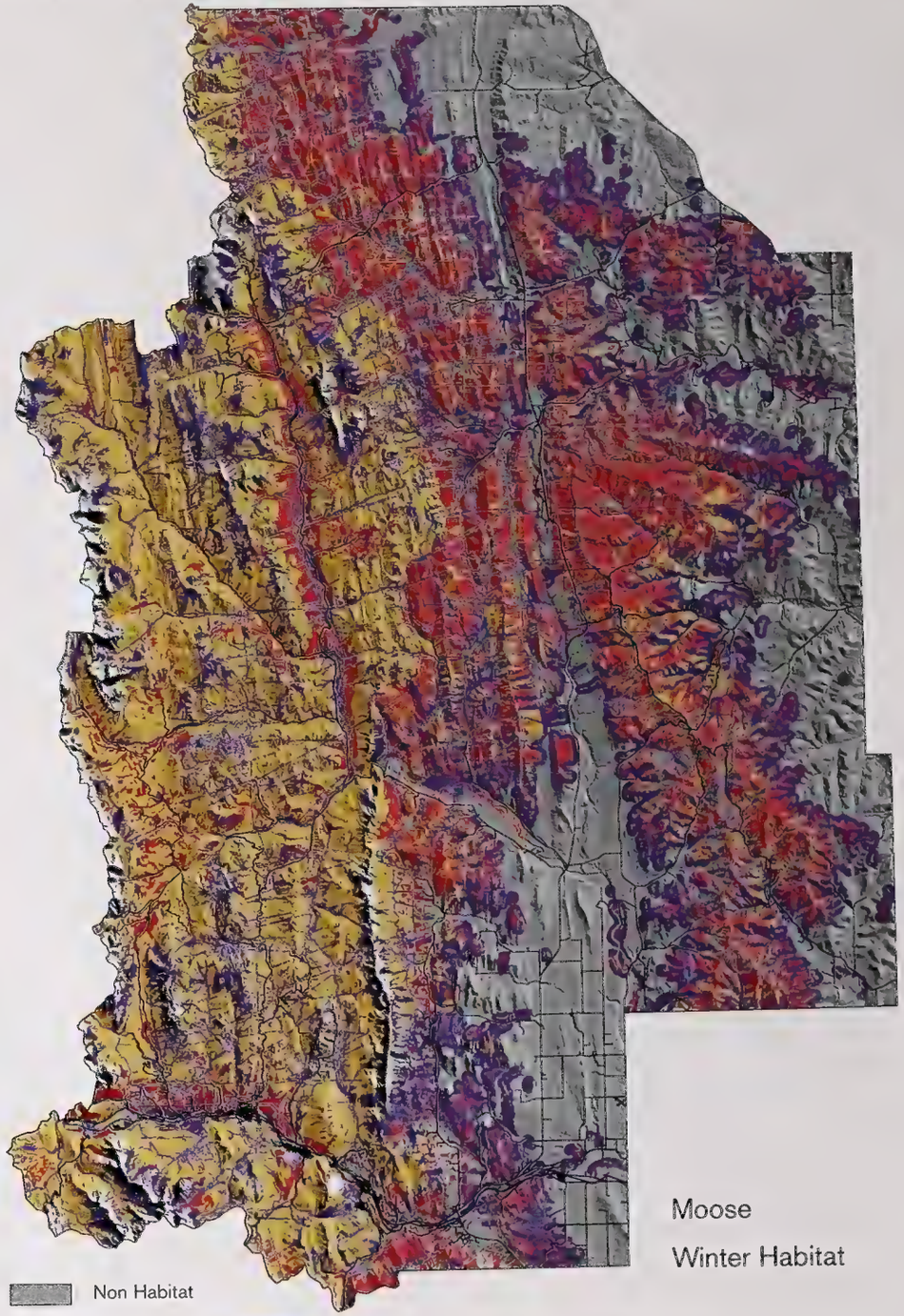
Preservation 50



Recreation 20



Recreation 50

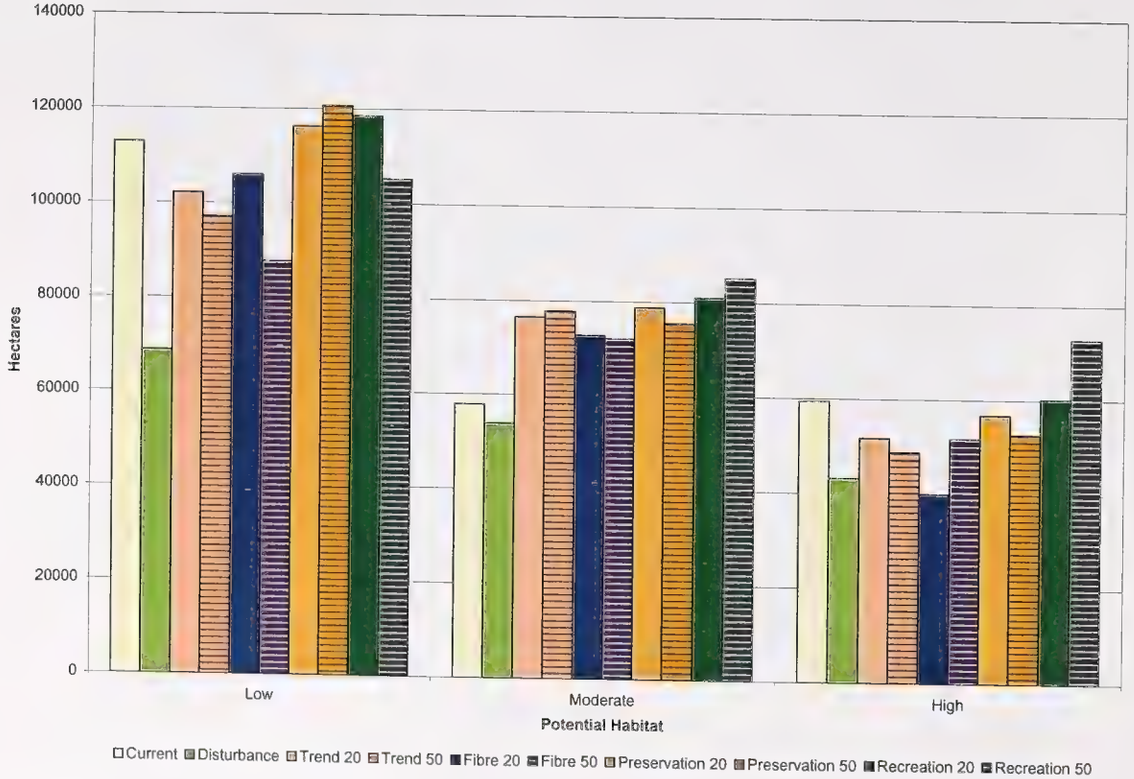


4.1.1.4. MARTEN
(Martes americana)

Marten has been selected as a modelling species based on their preference for mature conifer or mixedwood forests with snags and fallen logs for habitat components. Uneven–aged stands offer a diversity of tree sizes and age classes to provide hunting sites and cover. These are landscape characteristics that are subject to change.

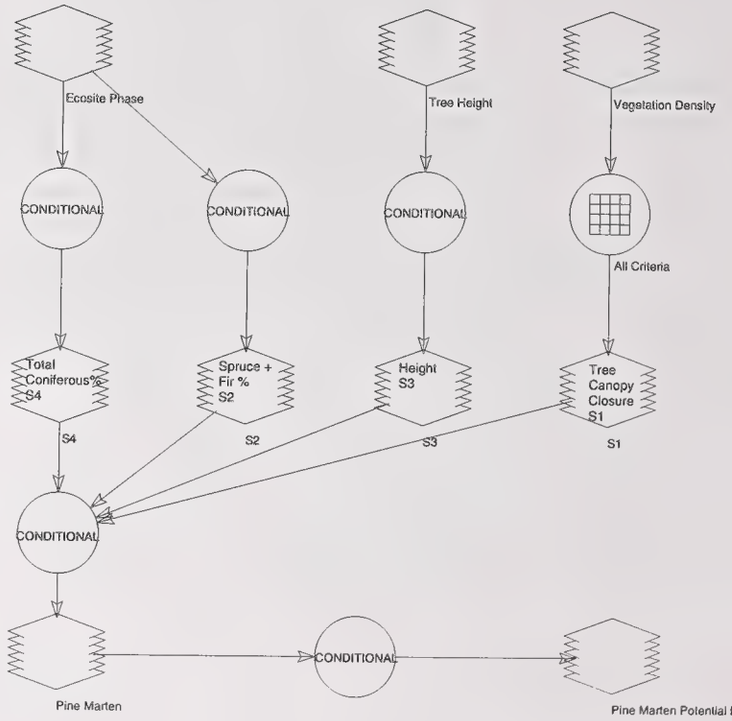
While marten may tolerate a variety of forest habitats if food and cover are available, they are susceptible to changes brought about by harvesting and fire. Extensive clearcuts and large fires will severely reduce habitat value for marten for as many as 15 years (Clark, 1975). Small clearcuts with snags, debris piles and a high slash loading within the cutblock may be acceptable habitat for the marten. Suitable high forest cover surrounding the cut is needed (Hurrell, 1968). Uncut strips, at least 100 meters wide along waterways, are often utilized by marten (Snyder, 1984). Larger clearcuts will require residual islands for cover and hunting structure. The model uses ecosite phase, tree height and stand density as primary inputs. Total coniferous cover, the percentage of spruce and fir in the canopy, tree height and canopy closure all contribute to marten habitat.

Figure 63. Area of Potential Marten Habitat – All Scenarios



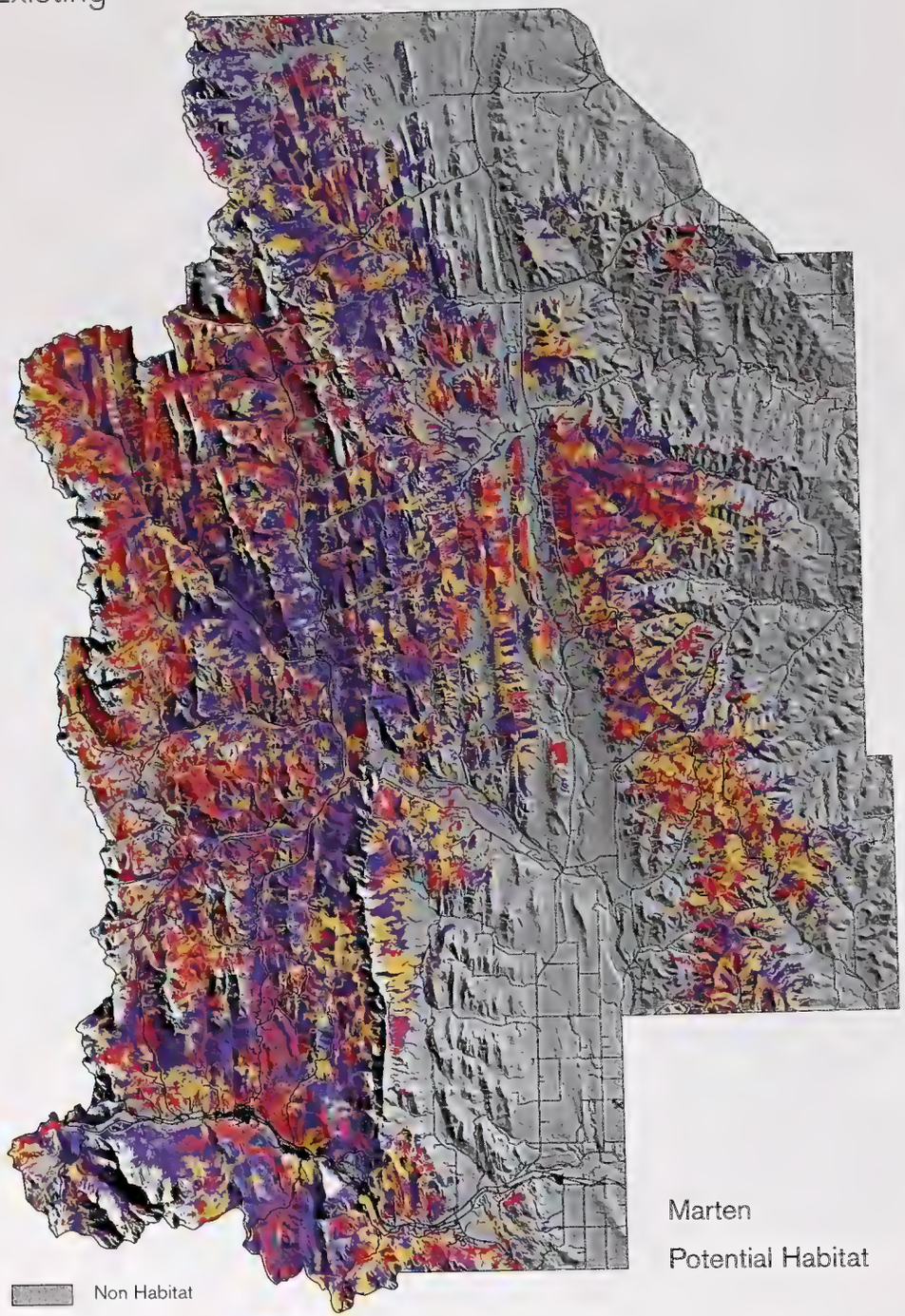
The Disturbance Scenario results in a loss of habitat in all three categories due mainly to a loss of mature forest. The Trend Scenario shows a modest decline in high quality habitat while increasing moderate quality habitat. The Fibre Scenario also appears to maintain marten habitat at or near existing levels. However, this habitat would be conditional on retention of coarse woody debris in the blocks and many large residual islands. It is also expected that under this scenario, important riparian hunting areas would be heavily impacted.

Figure 64. Potential Marten Habitat Graphical Model



The Preservation Scenario increases overall marten habitat due to the retention of older growth, large diameter forest as well as the moderate size of the prescribed burn openings. The Recreation Scenario shows the greatest improvement in marten habitat as very little harvesting is taking place and complete fire control is assumed. As no prescribed burns occur under this scenario, forest age increases with a corresponding increase in large diameter trees.

Existing



Marten

Potential Habitat

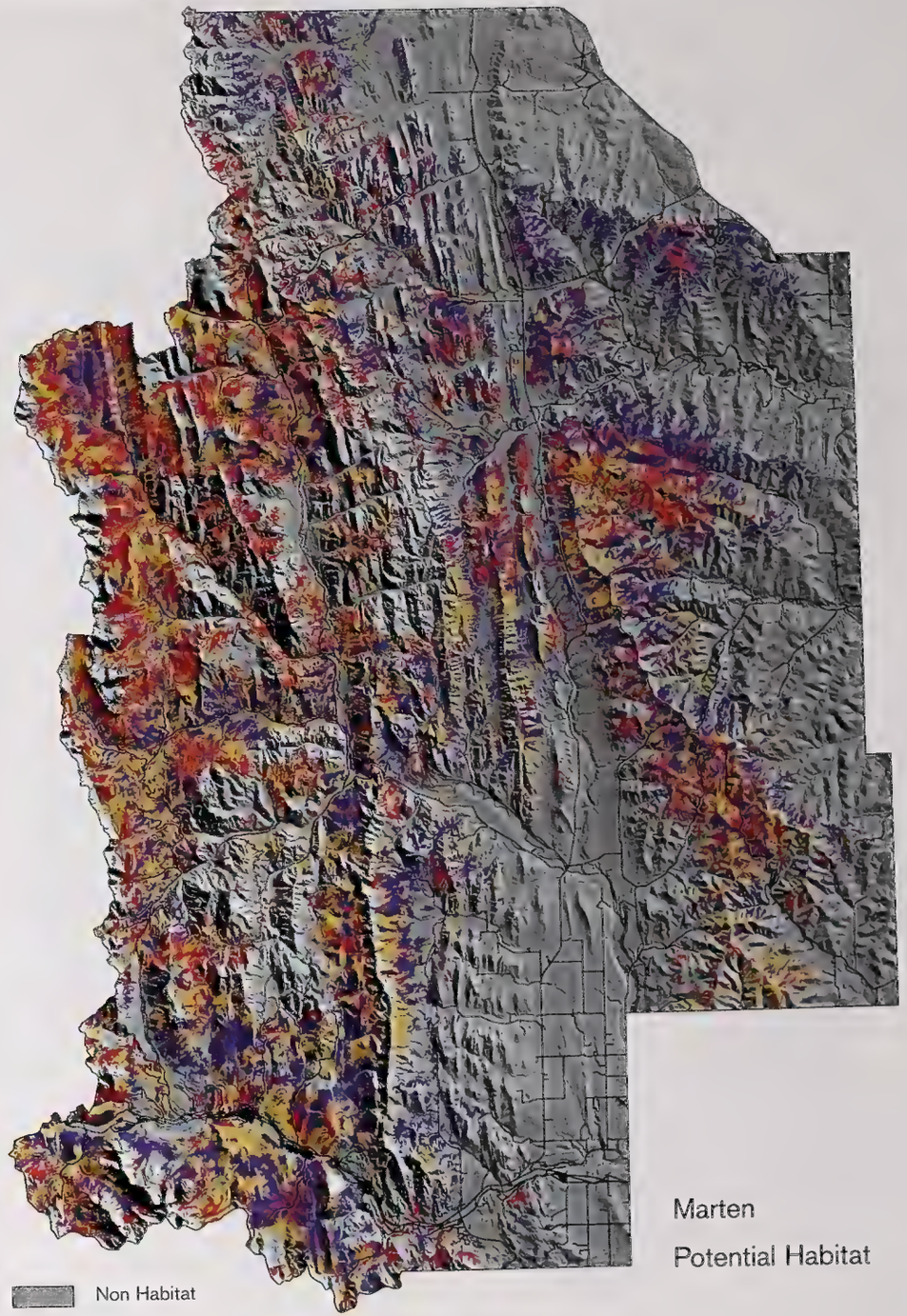
Non Habitat

Lowest

Moderate

Highest

Disturbance



Marten

Potential Habitat

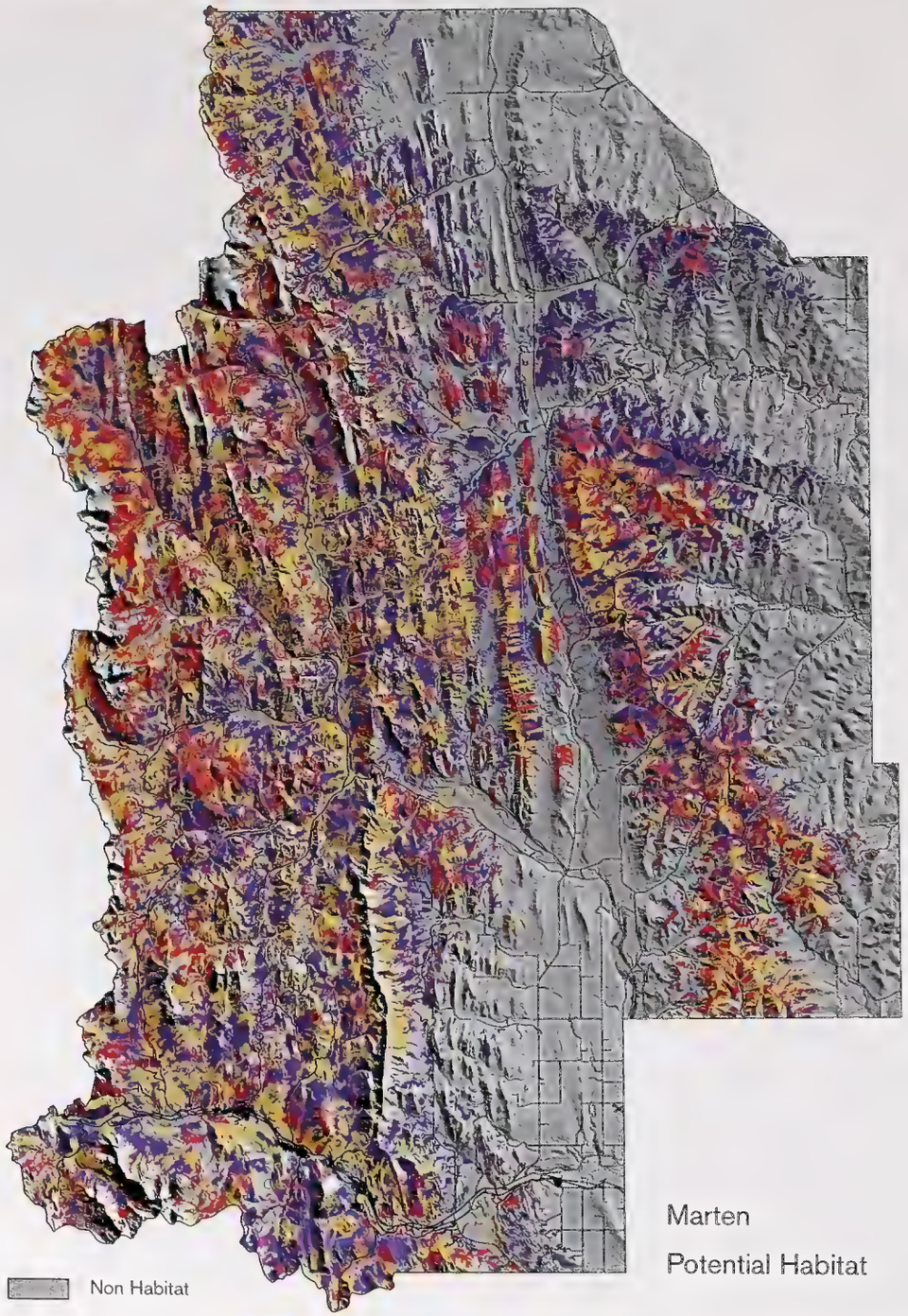
Non Habitat

Lowest

Moderate

Highest

Trend 20



Marten

Potential Habitat

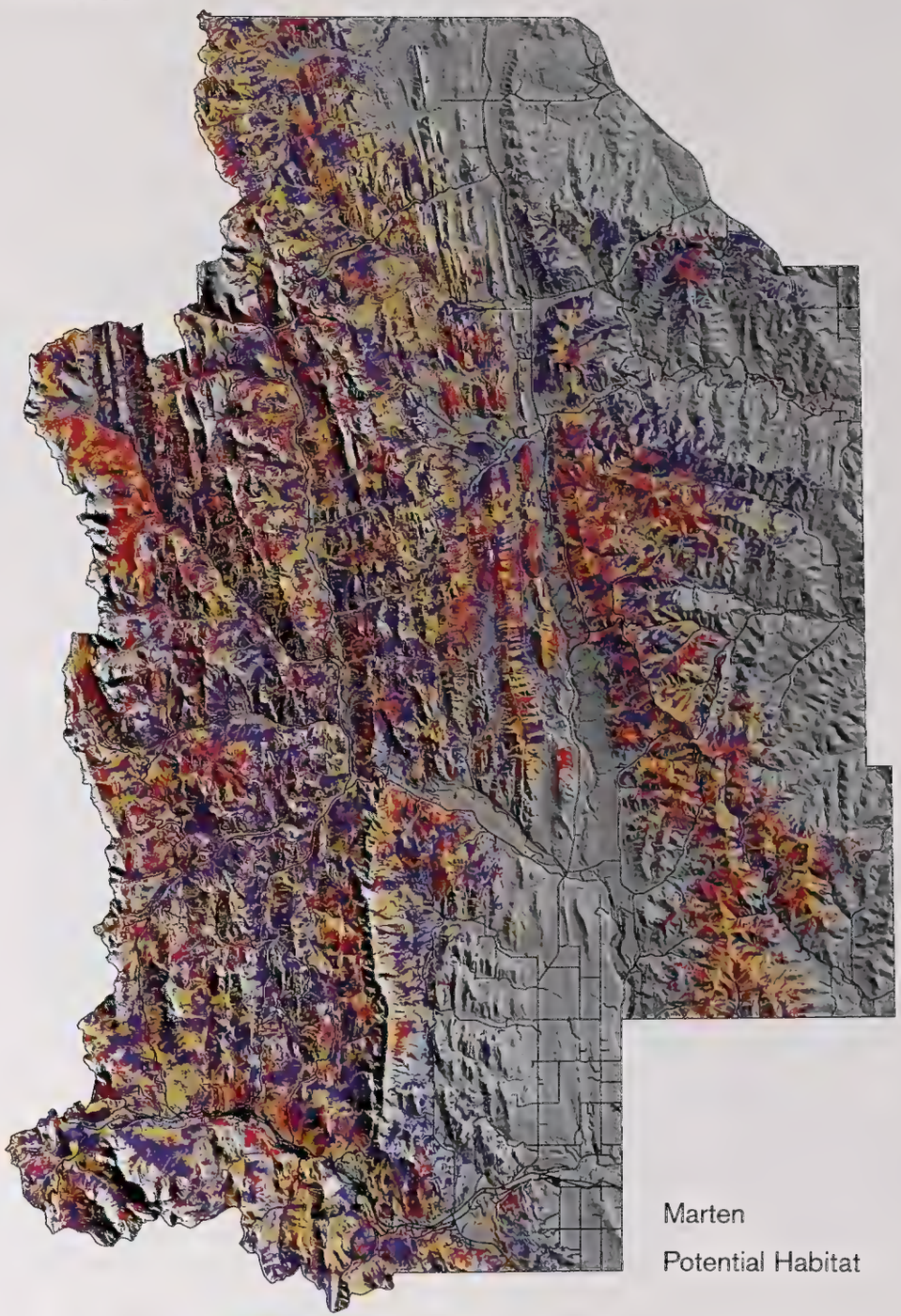
Non Habitat

Lowest

Moderate

Highest

Trend 50



Marten

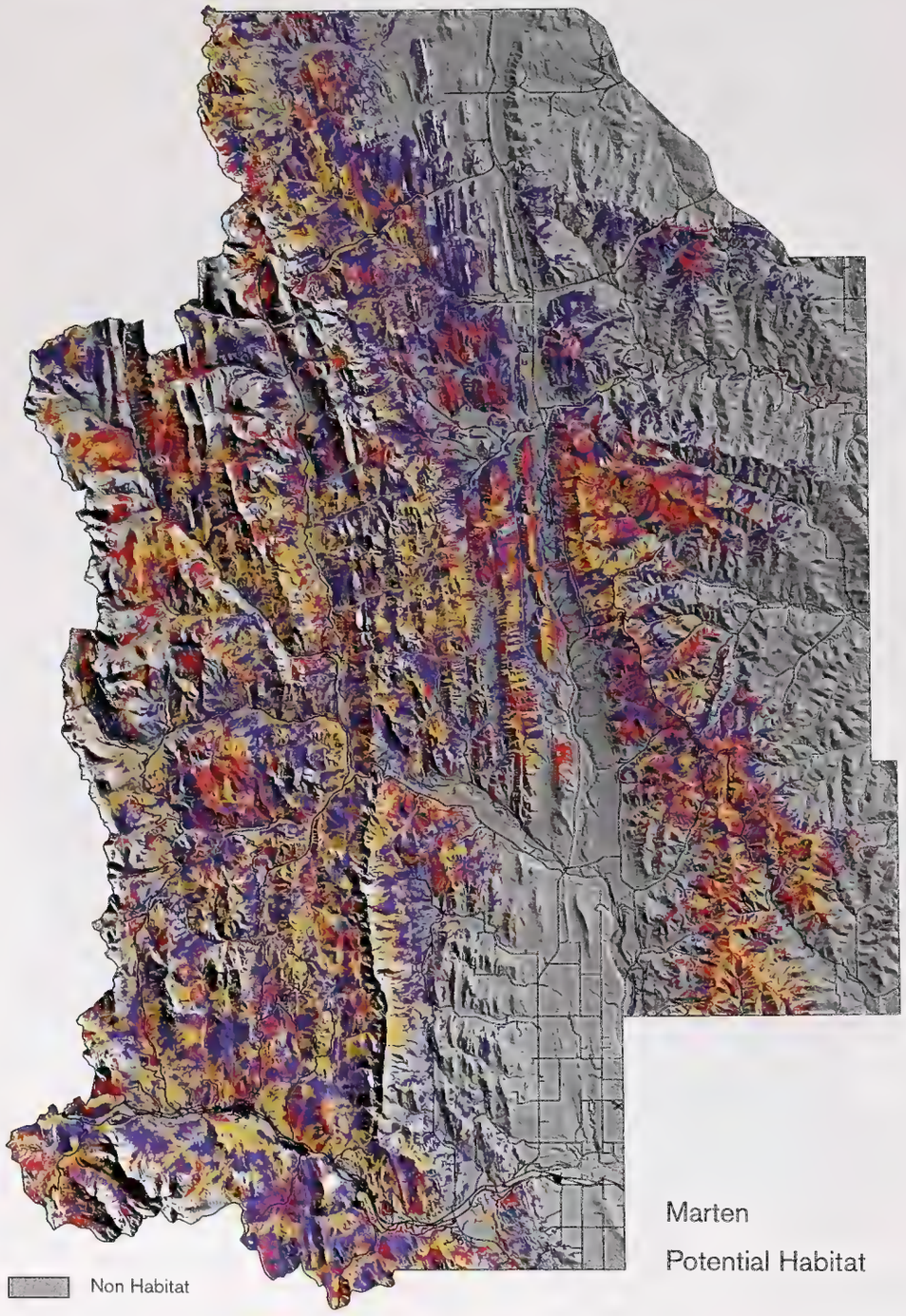
Potential Habitat

Lowest

Moderate

Highest

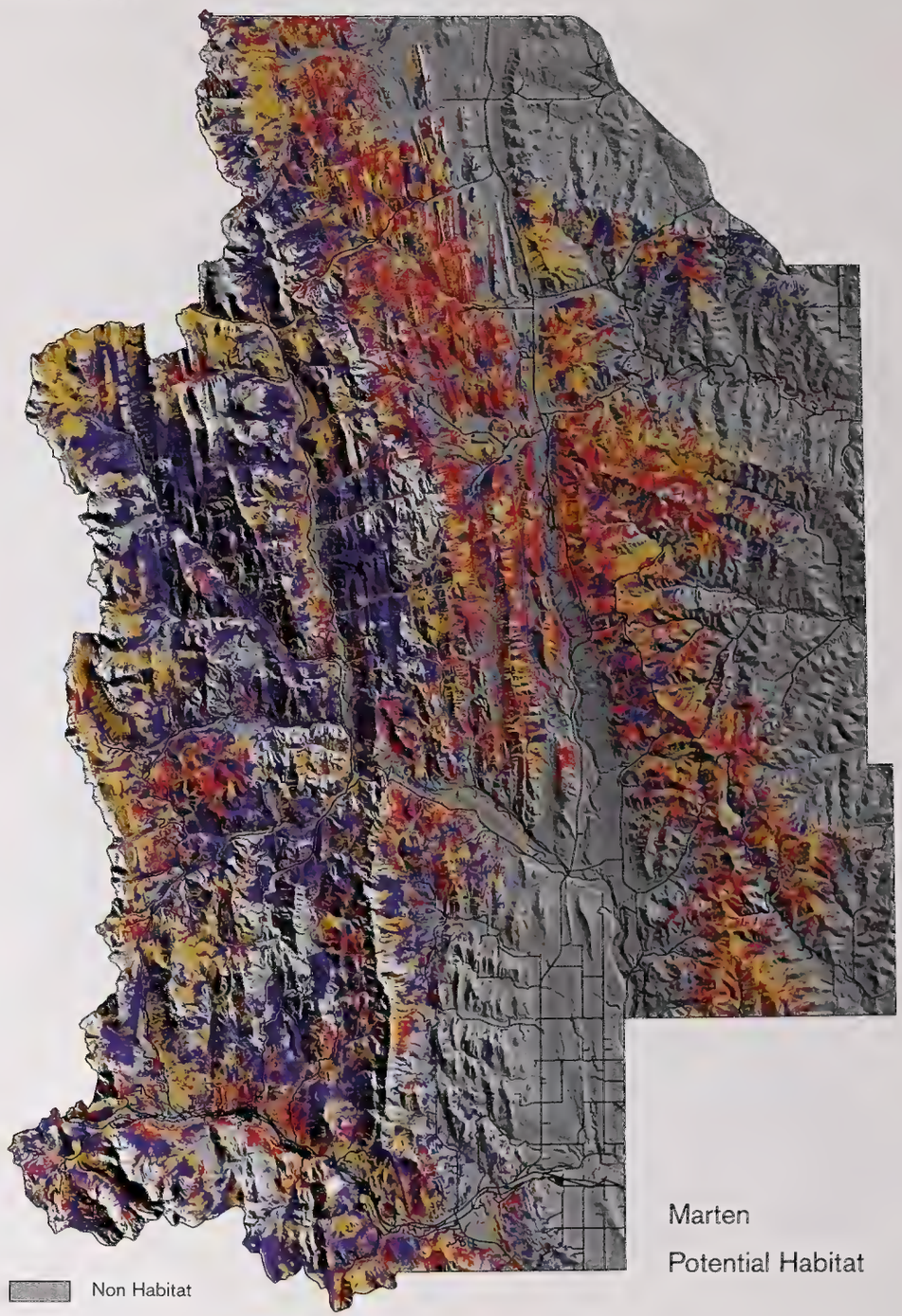
Fibre 20



Marten

Potential Habitat

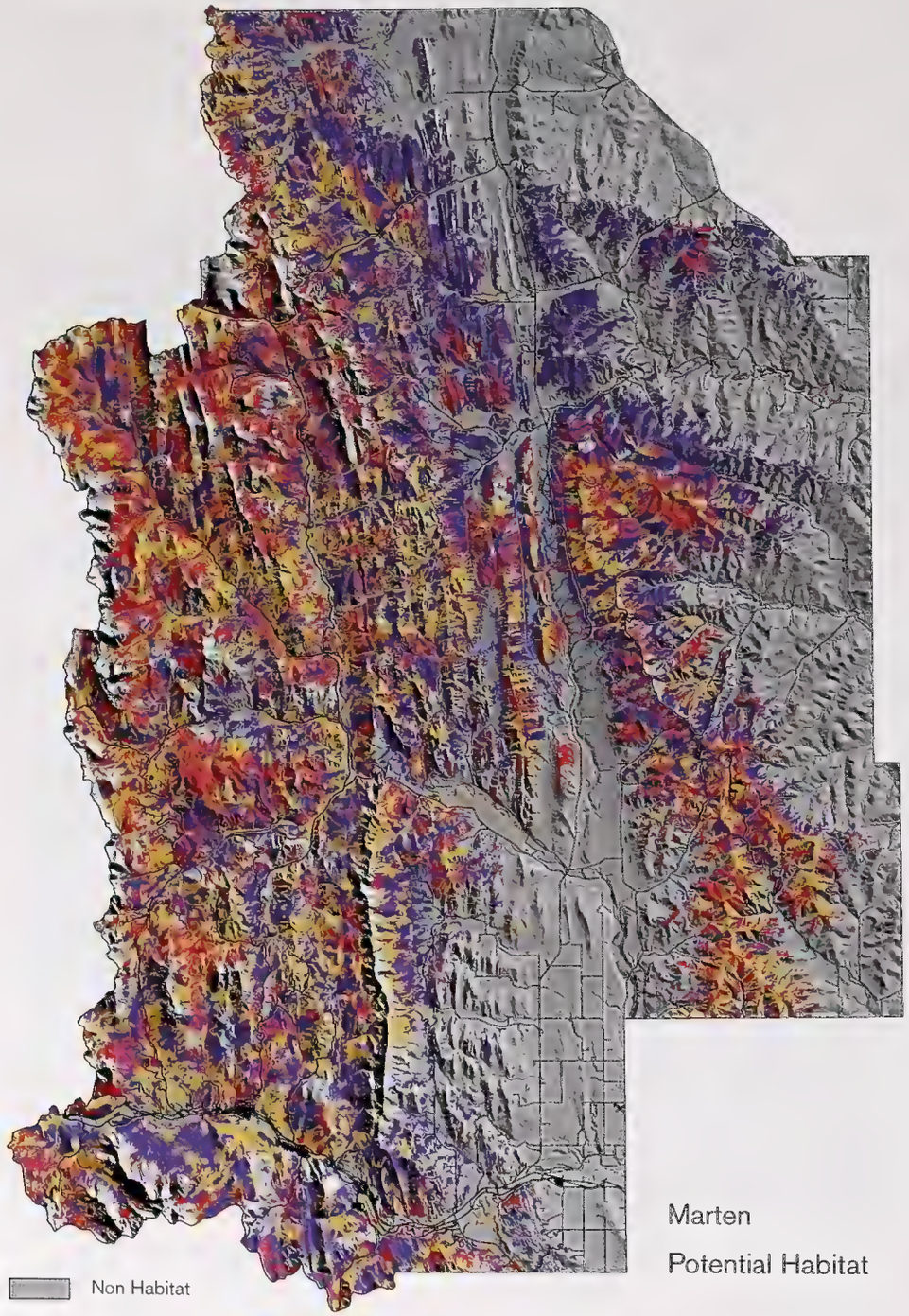
Fibre 50



Marten

Potential Habitat

Preservation 20



Marten

Potential Habitat

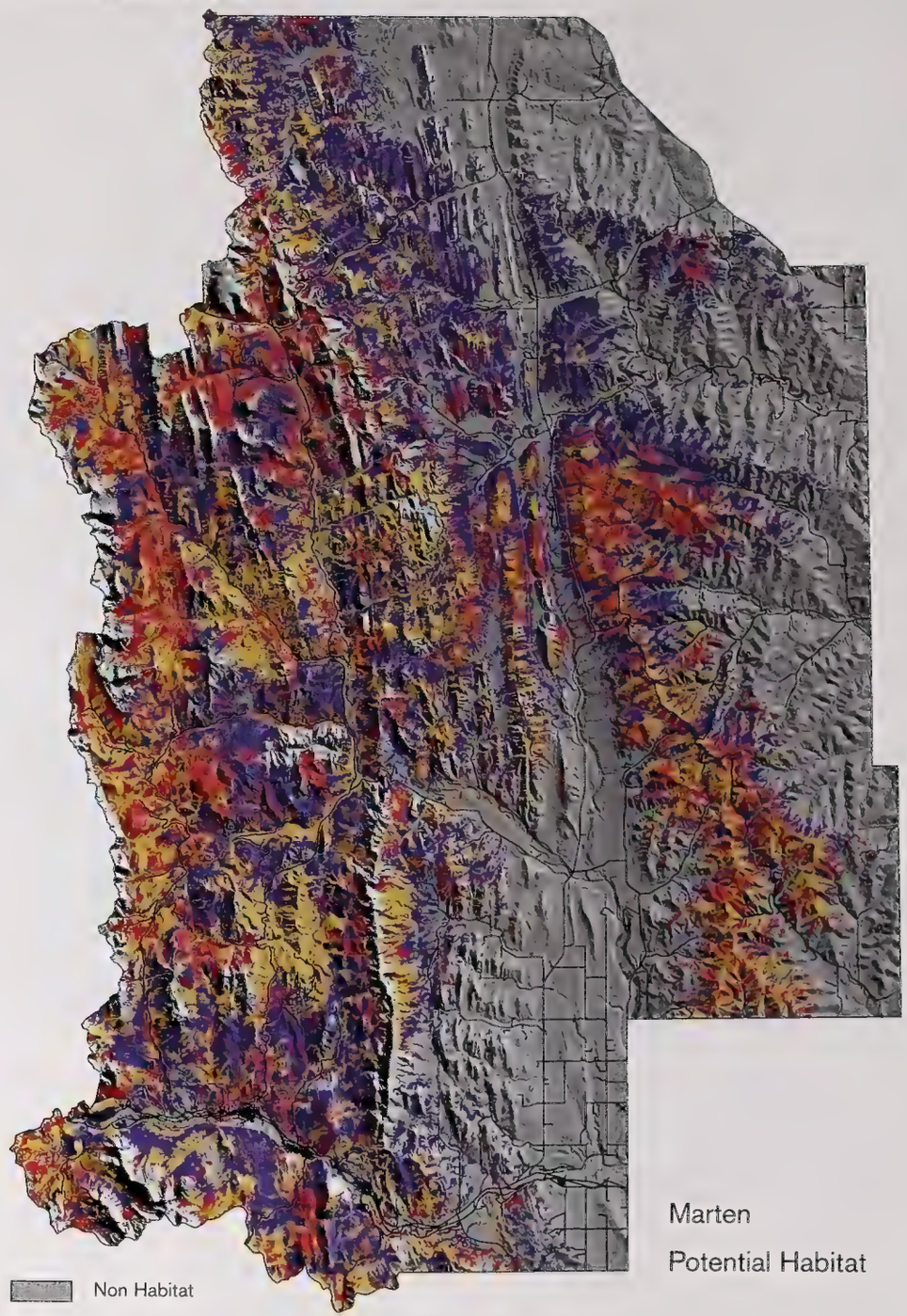
Non Habitat

Lowest

Moderate

Highest

Preservation 50



Marten

Potential Habitat

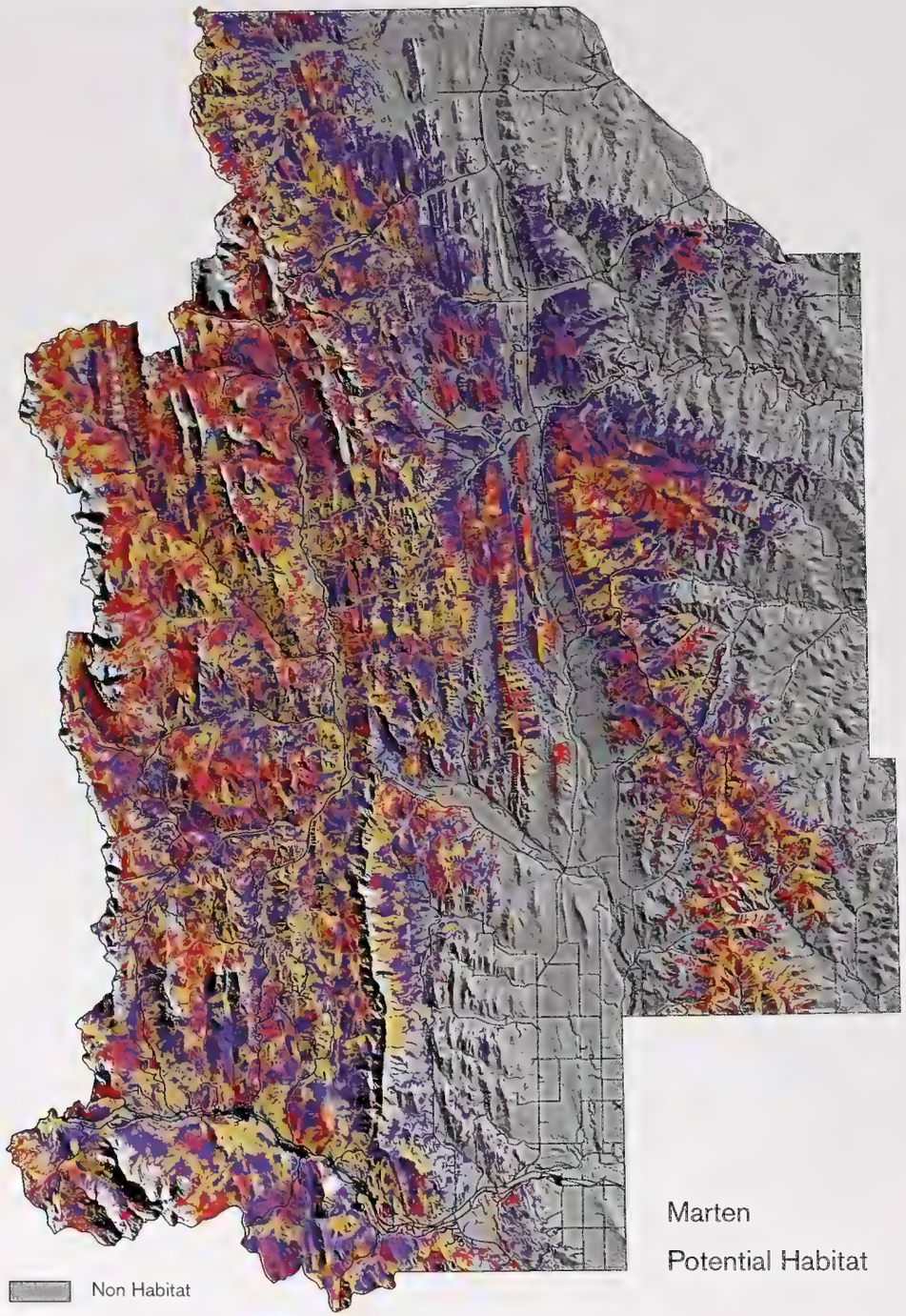
Non Habitat

Lowest

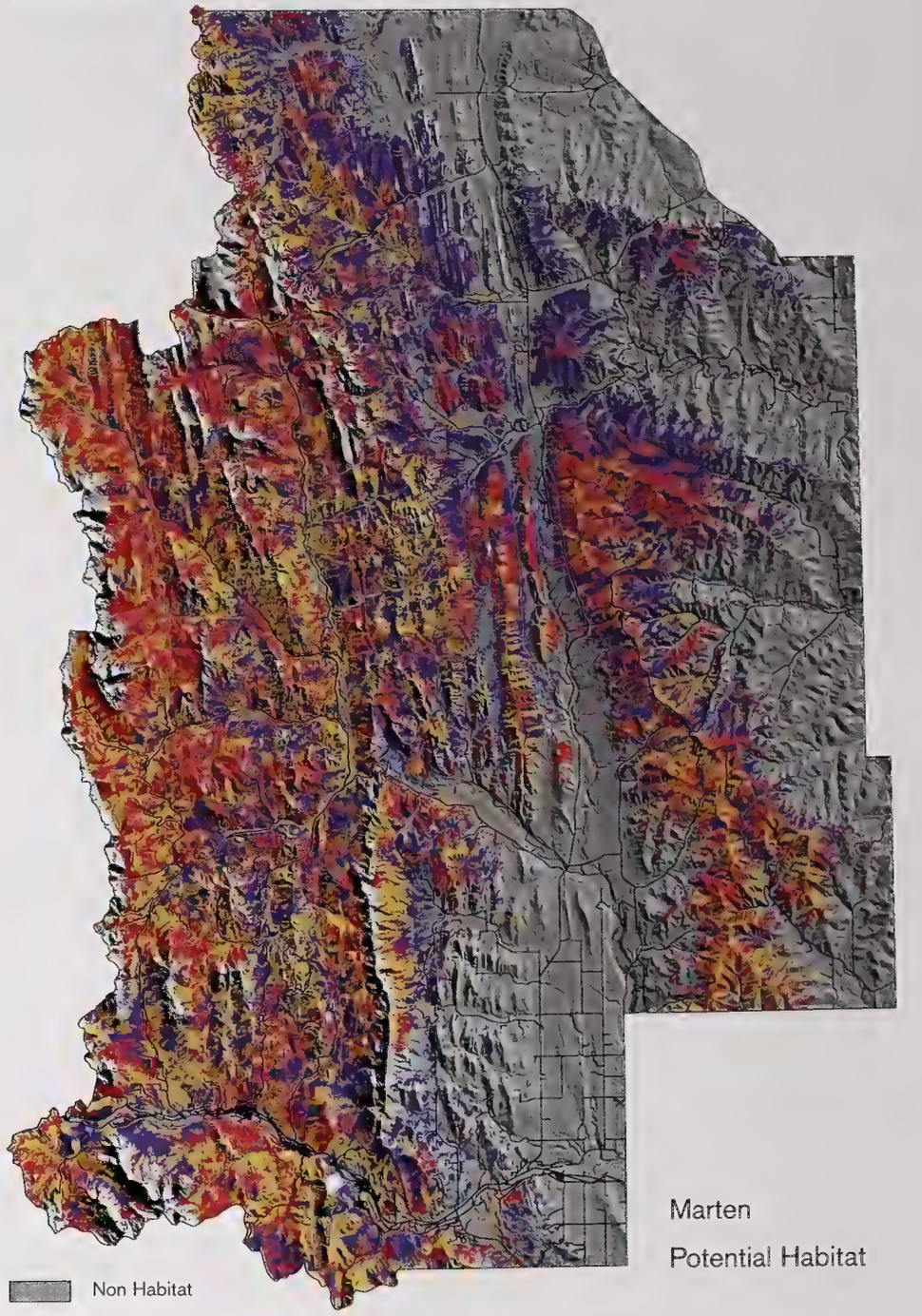
Moderate

Highest

Recreation 20



Recreation 50



4.1.1.5. MINK
(Mustela vison)

Mink have been chosen as modelling species as they are sensitive to changes in the quality of riparian environments which may be altered by future management. Mink occupy a variety of riparian wetland habitats, including streams, rivers, lakes, bogs and marshes where there is an abundance of prey. Important considerations in managing mink include maintaining the health of riparian zones and keeping log jams along the streams. Log jams are an important habitat element for the mink (Grinnell, 1937). While in–stream log debris is not included in the mink model, riparian health is considered. Riparian health is also captured in other models such as the Generalized Landscape Pattern, where the amount of naturally vegetated stream side is considered, as well as in the WRENNS hydrological modelling which predicts stream flow timing and quantity. Mink are heavily dependent on fish and, therefore, any changes in stream flow, which are likely to influence fish habitat, are a concern.

The mink model is based upon several variables including canopy closure and vegetation type in riparian areas. The riparian areas have been identified by buffering from all major streams (stream orders 5, 6 and 7) as well as from all ponds and lakes and other wetlands. A minimum patch size for viable habitat was established at 20 ha.

Mink habitat in the area is very limited with approximately 8,000 ha in the entire study area (1.6% of the study area). The various future scenarios appear to have very little effect on mink. The Disturbance Scenario maintains habitat very close to existing levels. Over time, the Trend Scenario shows a modest drop in moderate quality habitat, but demonstrates a slight increase in highest quality area. The Fibre Scenario shows a loss in low and moderate quality areas, but a gain in the area of highest quality habitats. Despite the fact that the Fibre Scenario does not recognize stream buffers, the latter may be due to an overall increase in canopy density. The Preservation and Recreation Scenarios both have a modest positive impact on mink.

Figure 65. Area of Potential Mink Habitat – All Scenarios

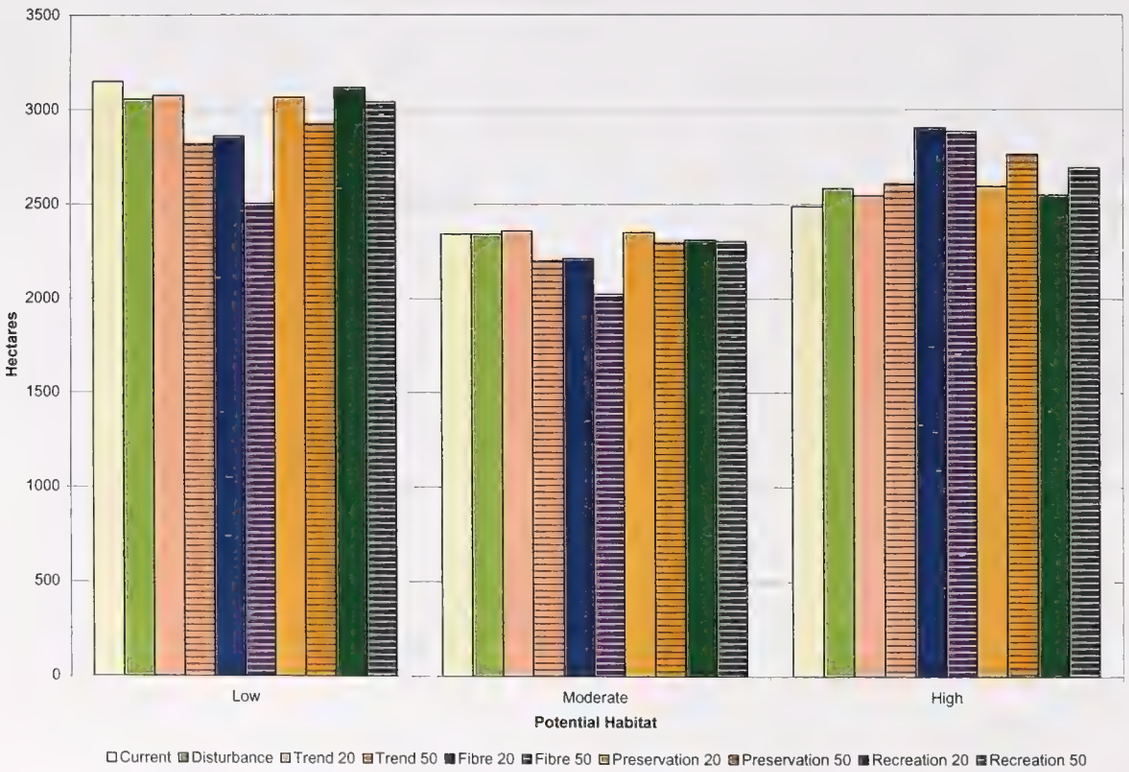
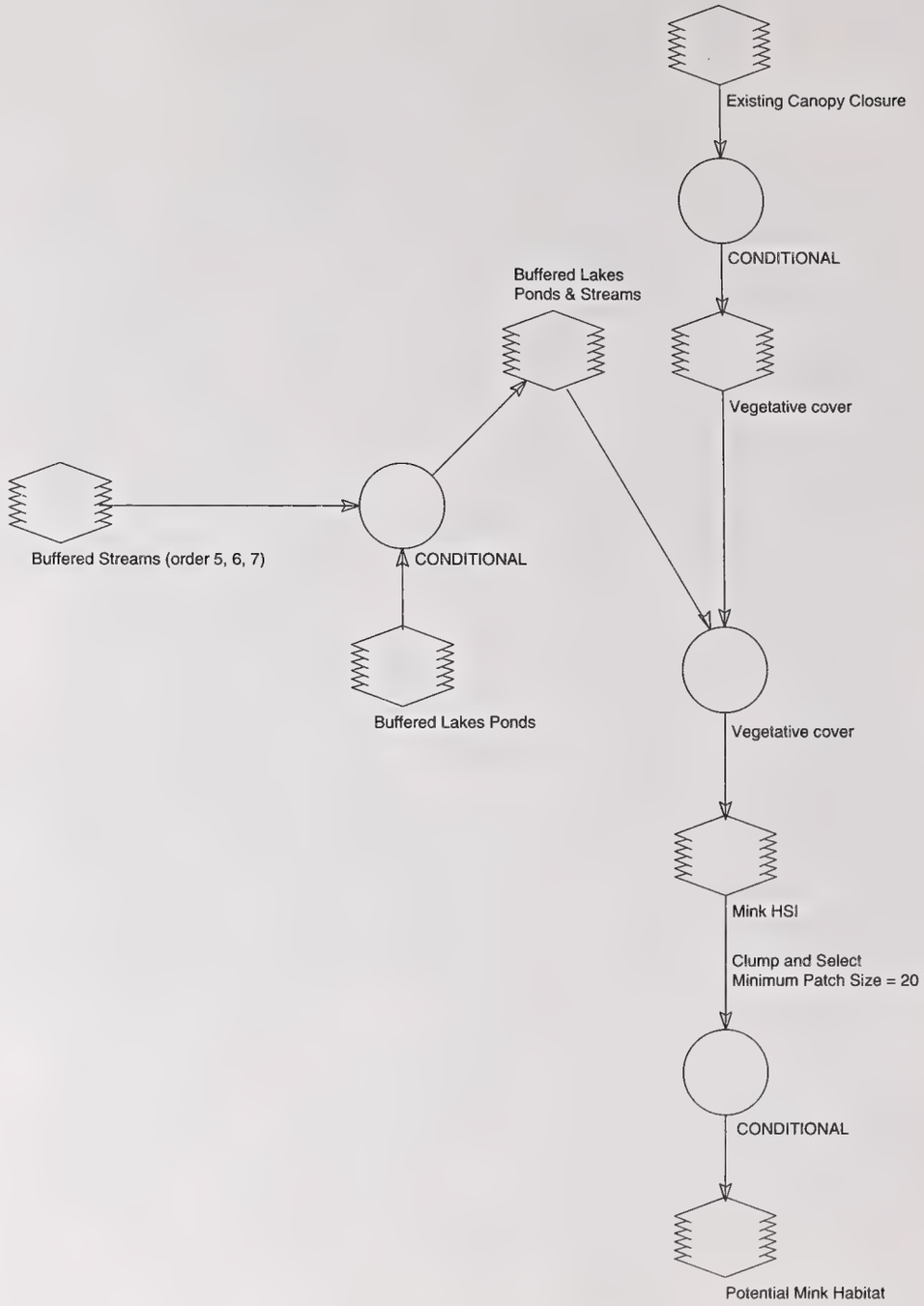


Figure 66. Potential Mink Habitat Graphical Model



Existing

Mink

Potential Habitat

Non Habitat

Lowest

Moderate

Highest

Disturbance

Mink

Potential Habitat

Non Habitat

Lowest

Moderate

Highest

Trend 20

Trend 50

Fibre 20

Mink

Potential Habitat

Non Habitat

Lowest

Moderate

Highest

Fibre 50

Mink

Potential Habitat

Non Habitat

Lowest

Moderate

Highest

Preservation 20

Mink

Potential Habitat

Non Habitat

Lowest

Moderate

Highest

Preservation 50

Mink

Potential Habitat

Non Habitat

Lowest

Moderate

Highest

Recreation 20

Recreation 50

4.1.1.6. PILEATED WOODPECKER
(Dryocopus pileatus)

The optimum habitat for the pileated woodpecker is roughly synonymous with old growth forest. Old growth forest provides the habitat structure necessary for both nesting and feeding (Bull, 1975). The preferred nesting areas are uneven–aged stands with a crown closure of approximately 70% (Bull, 1975). Suitable nesting trees for the pileated woodpecker are dead trees (snags) with heart rot. Generally, these must be more than 50 cm in diameter at breast height (Bull, 1975). A minimum diameter of 35 cm has been used in the model.

The primary food source of the pileated woodpecker are carpenter ants and their larvae which are found in trees with heart rot (Bull, 1975). Another source of food for the woodpecker is bark beetles and their larvae, which may be found under the bark of mature pine or spruce trees.

The territorial requirement of the pileated woodpecker is approximately 120 hectares; therefore, stand sizes should be a multiple of that number in order to maximize the population density and utility of the area for the woodpecker (Thomas, et. al., 1979). However, a minimum patch size has not been used in the model. Where old growth stands already exist, consideration should be given to maintaining an uneven–aged stand structure, with approximately 70% crown closure. Stand management needs to be combined with an active snag management program.

The various scenarios all impact pileated woodpeckers to varying degrees. The Disturbance Scenario shows a high impact in the low quality habitat with decrease in the moderate classes and a slight increase in high quality. Burns affect both nesting and foraging habitat. The Trend Scenario maintains conditions very close to that of the current situation in the moderate quality habitats, but shows a marked decrease in the lowest quality. The increase in highest quality is due to areas outside of the net land base which are growing older and therefore, more suitable. Preservation and Recreation both show an increase in highest quality habitat due to an increasingly older and larger average diameter forest.

Figure 67. Area of Potential Wood Pecker Habitat – All Scenarios

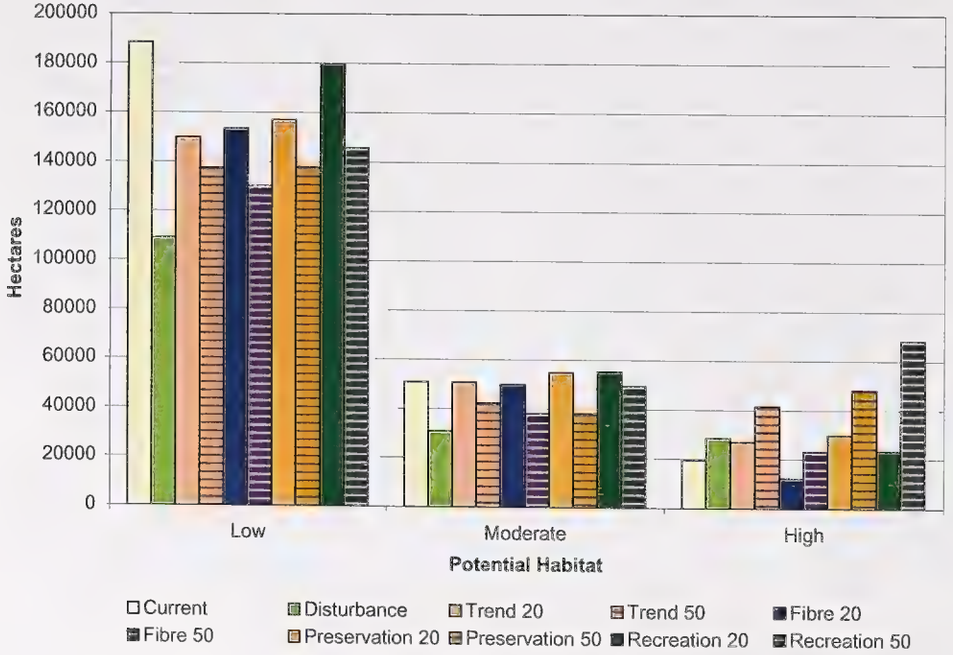
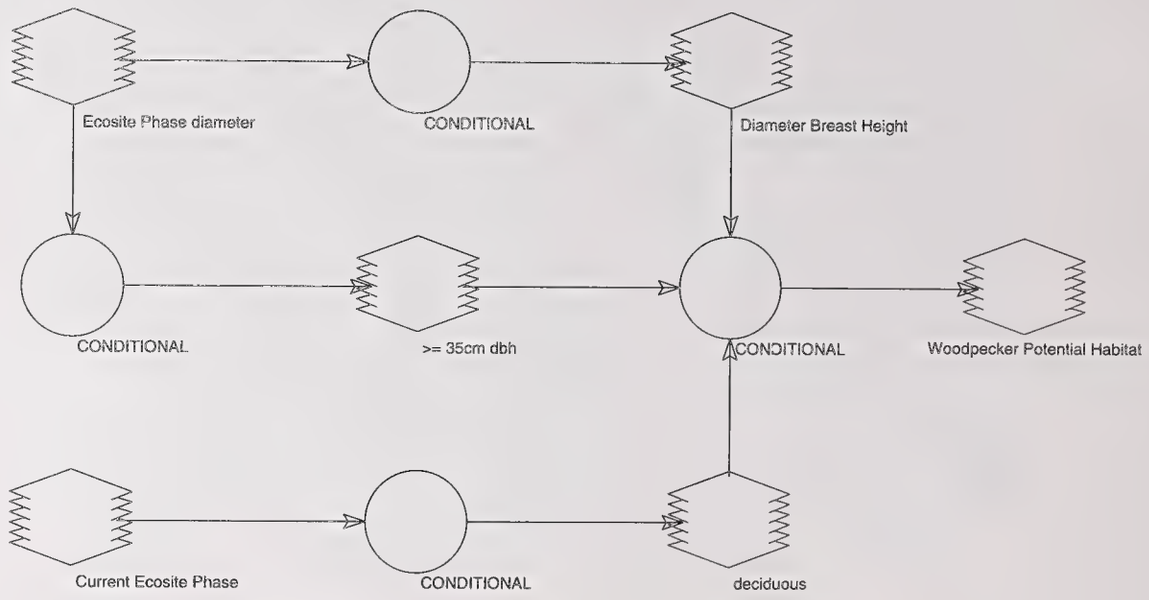
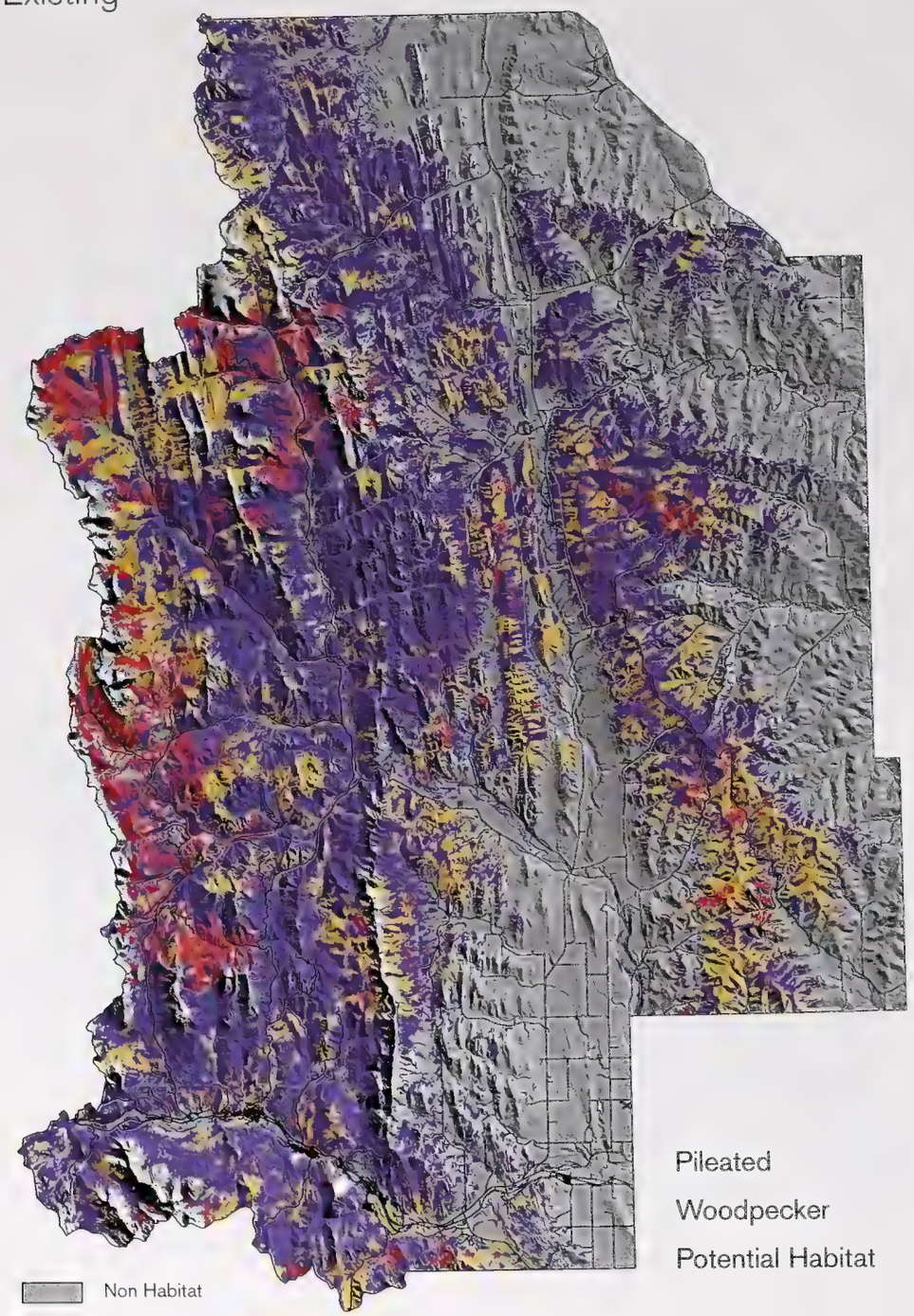


Figure 68. Potential Woodpecker Habitat Graphical Model



Existing



Pileated Woodpecker Potential Habitat

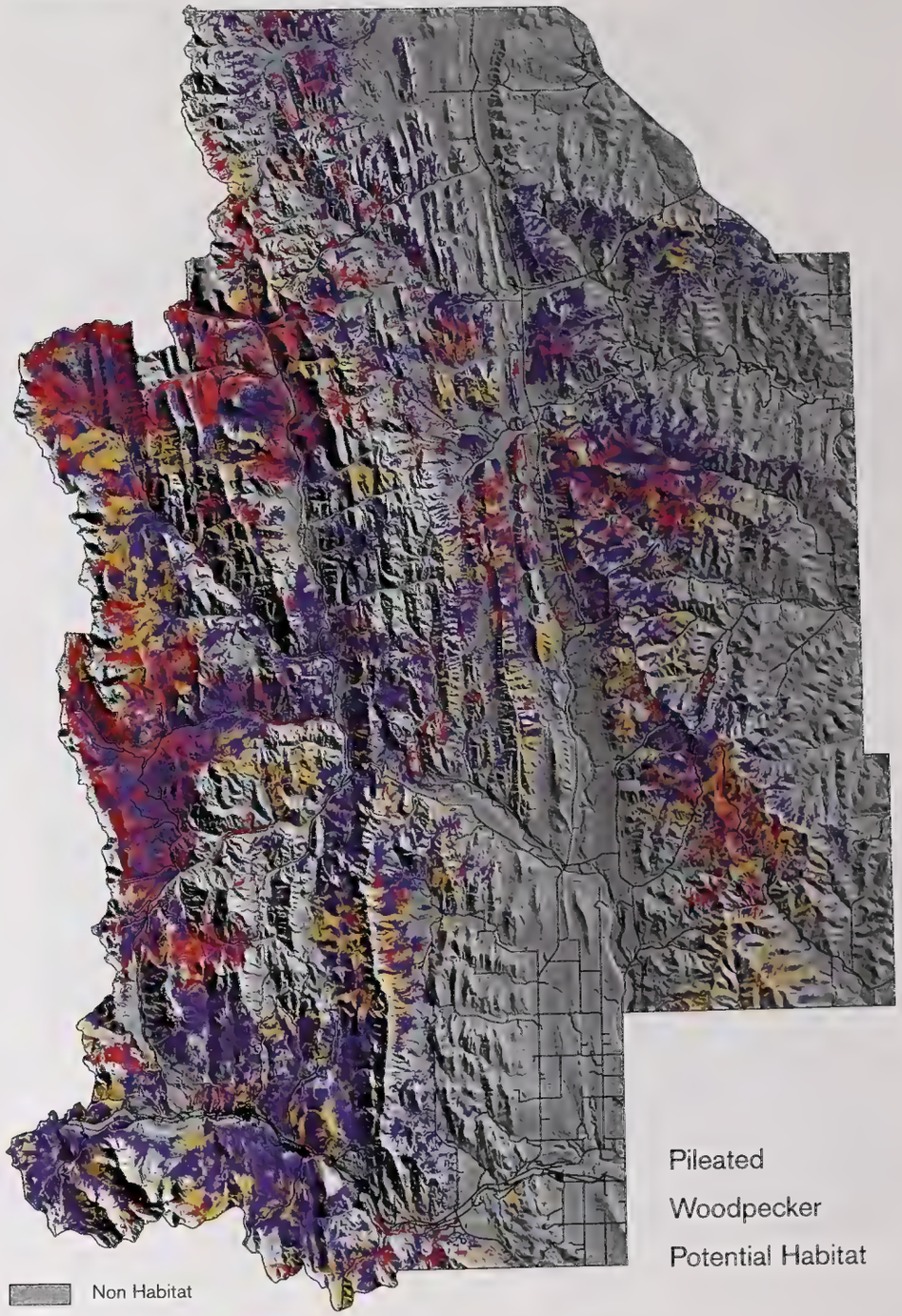
Non Habitat

Lowest

Moderate

Highest

Disturbance



Pileated Woodpecker Potential Habitat

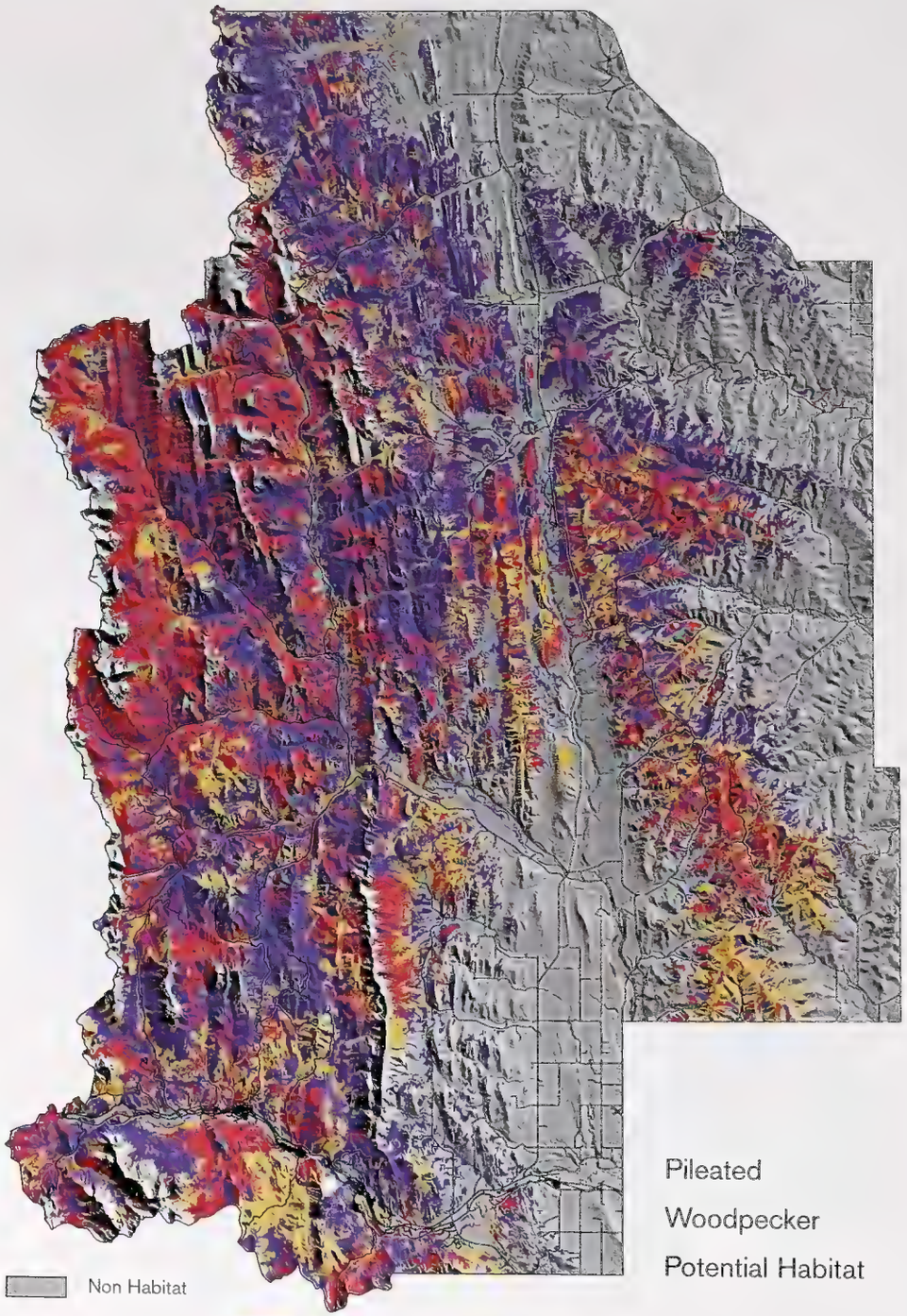
Non Habitat

Lowest

Moderate

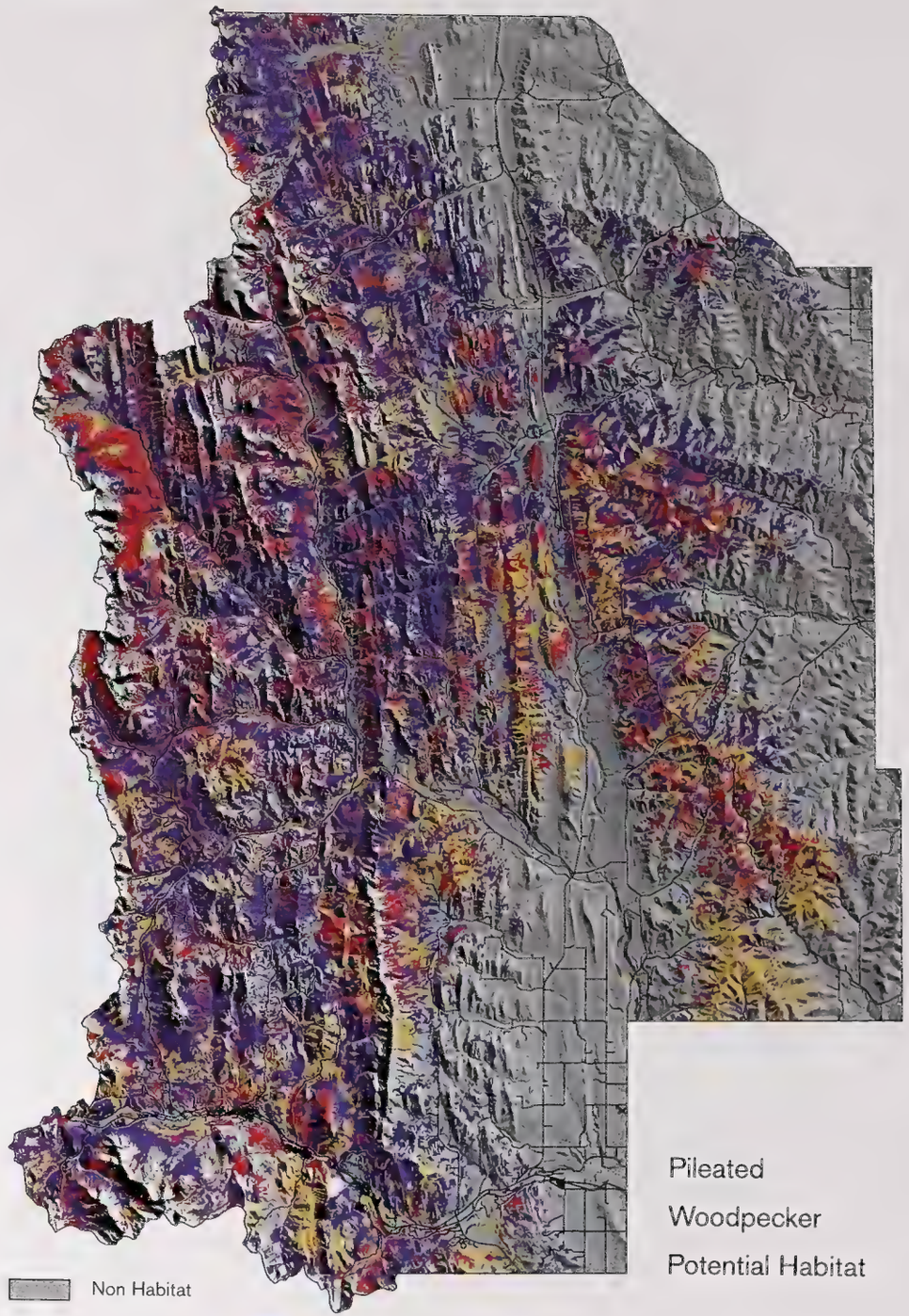
Highest

Trend 20



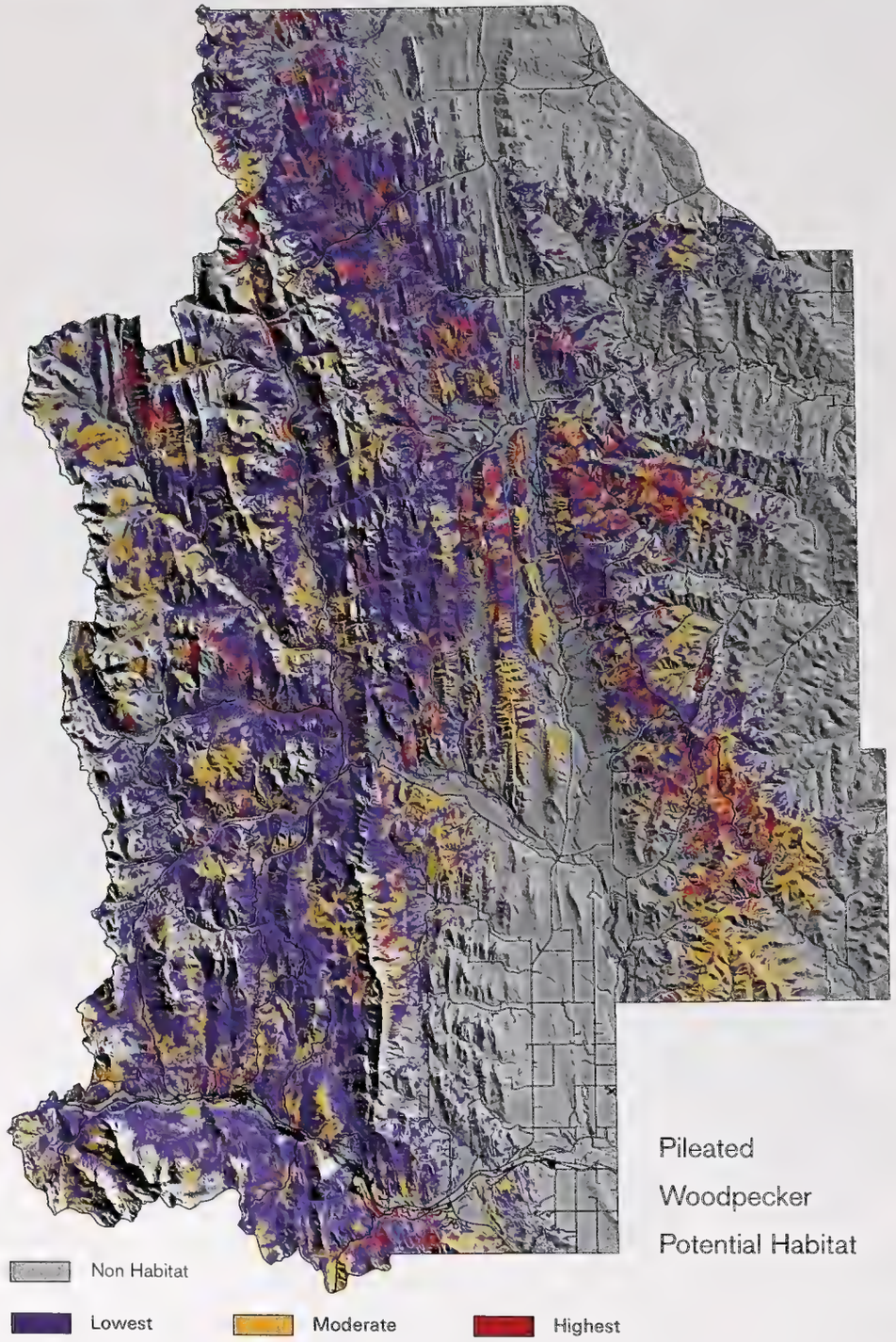
Pileated
Woodpecker
Potential Habitat

Trend 50



Pileated
Woodpecker
Potential Habitat

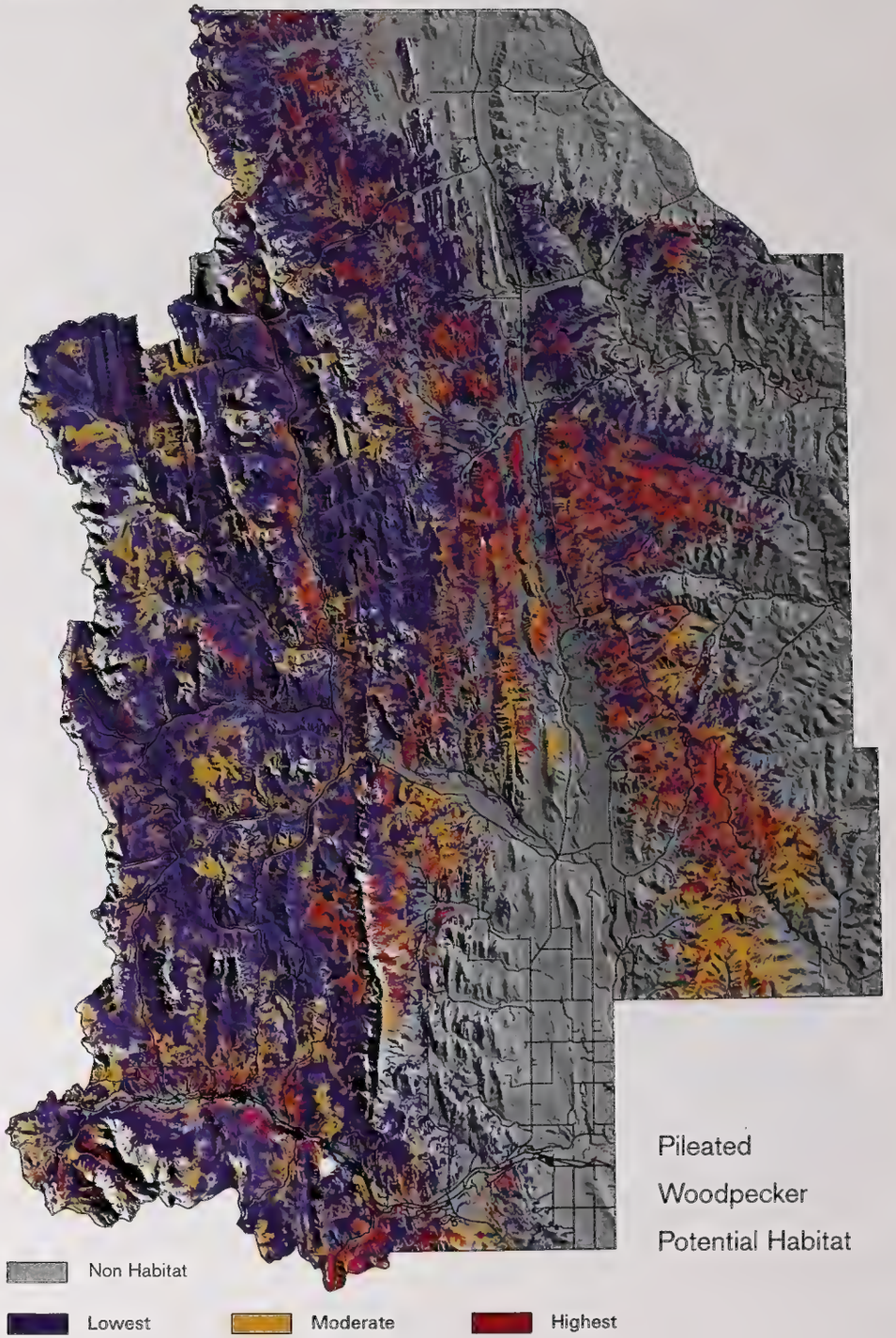
Fibre 20



Pileated
Woodpecker
Potential Habitat

Non Habitat
Lowest
Moderate
Highest

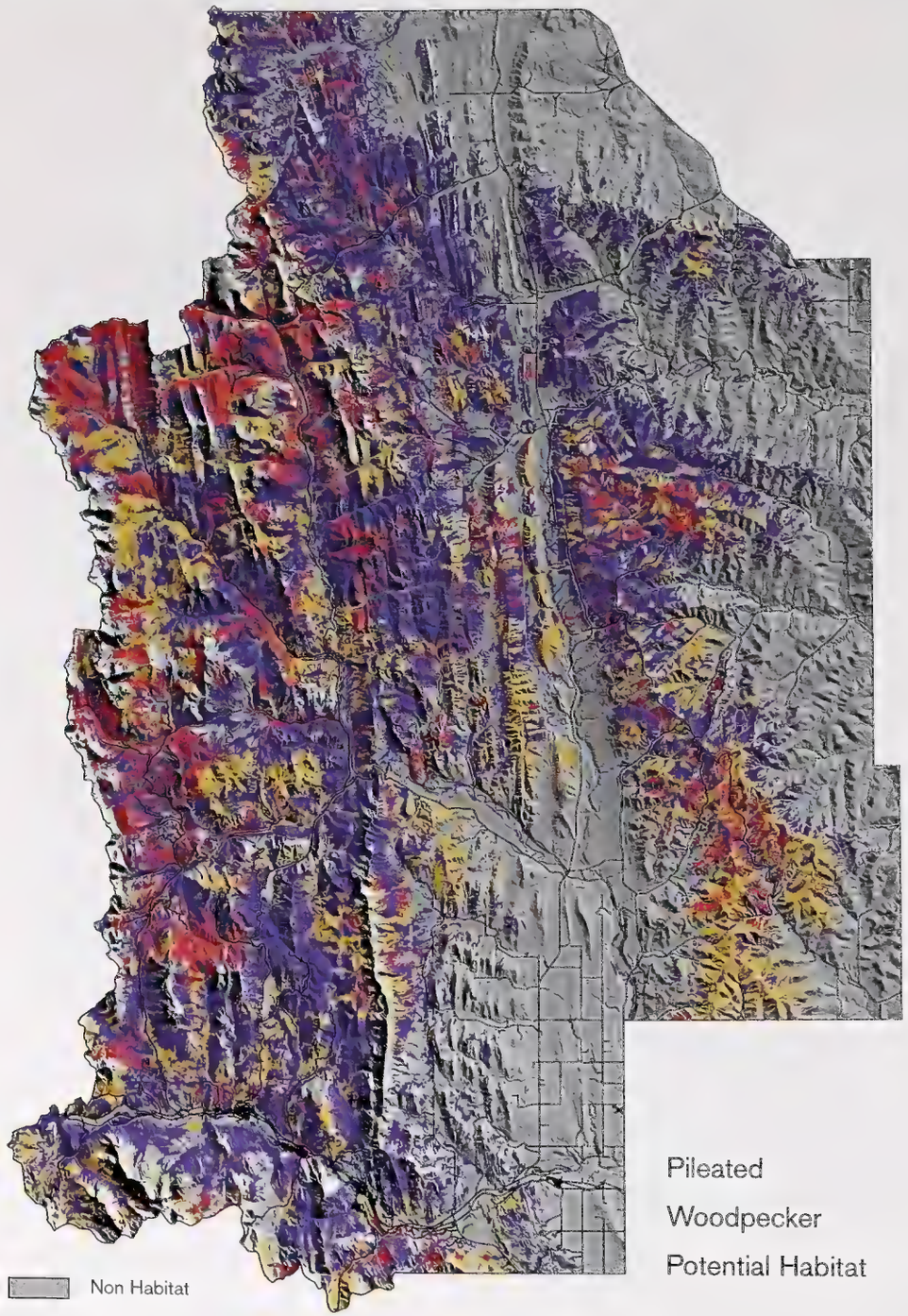
Fibre 50



Pileated
Woodpecker
Potential Habitat

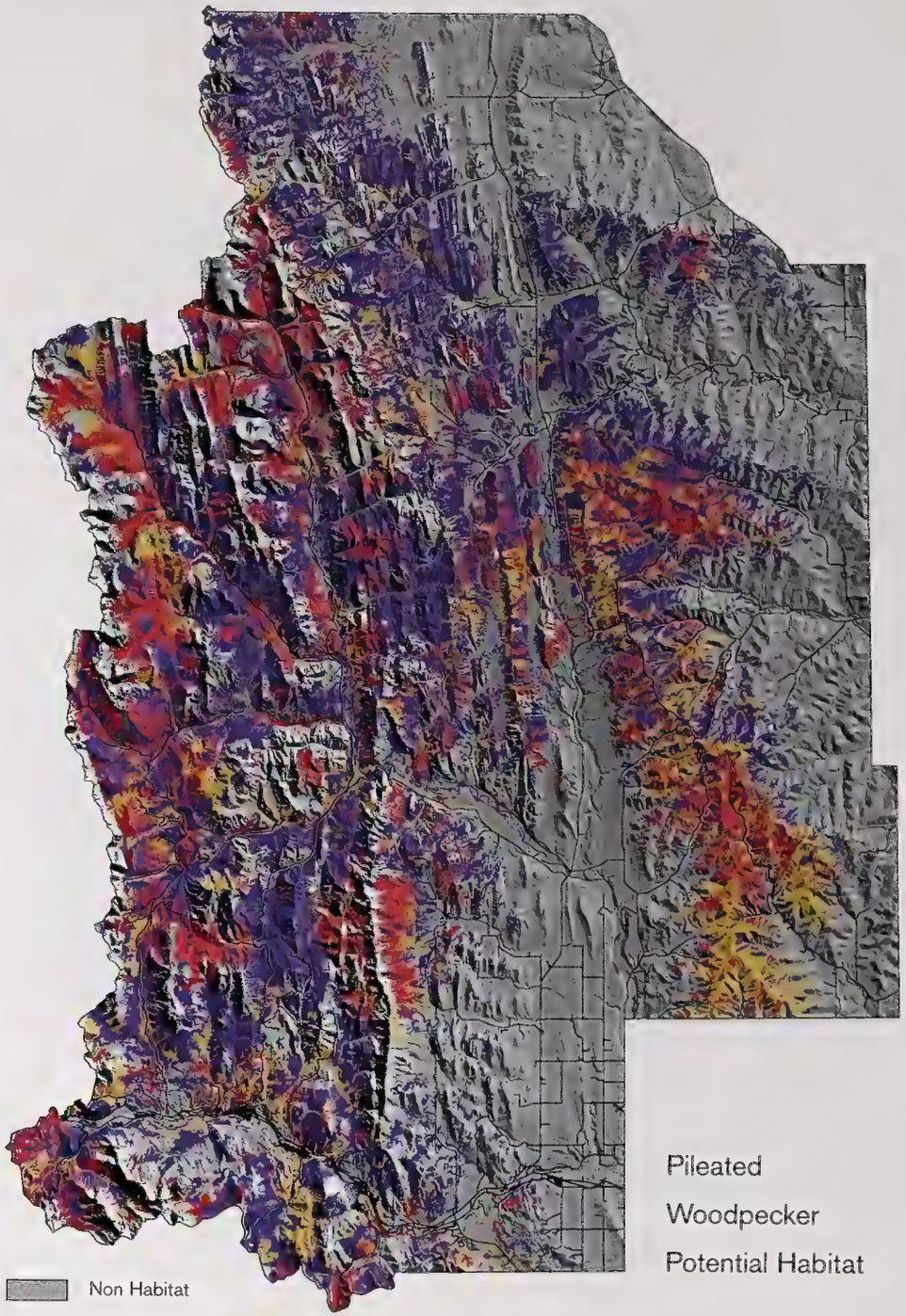
Non Habitat
Lowest
Moderate
Highest

Preservation 20



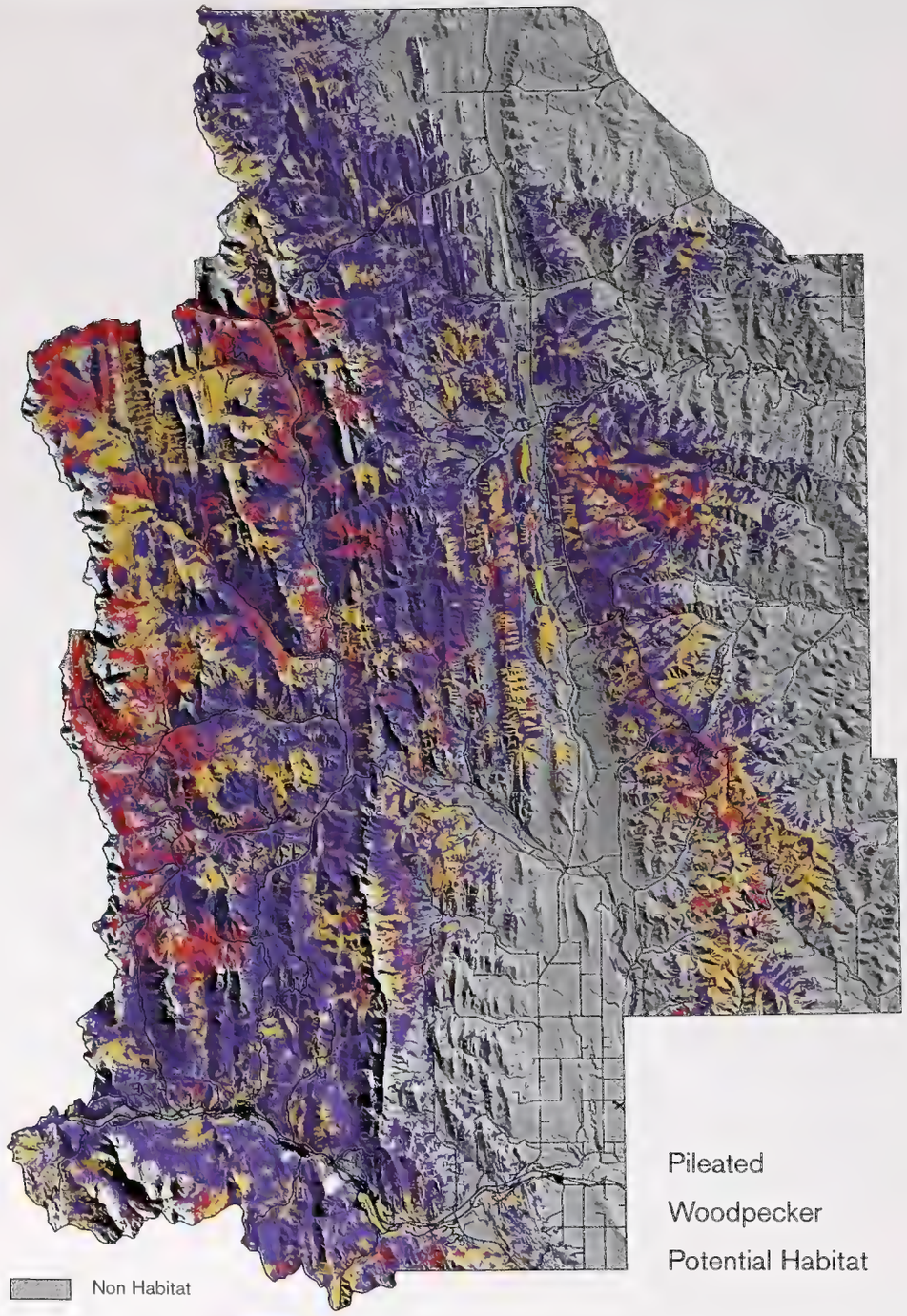
Pileated
Woodpecker
Potential Habitat

Preservation 50

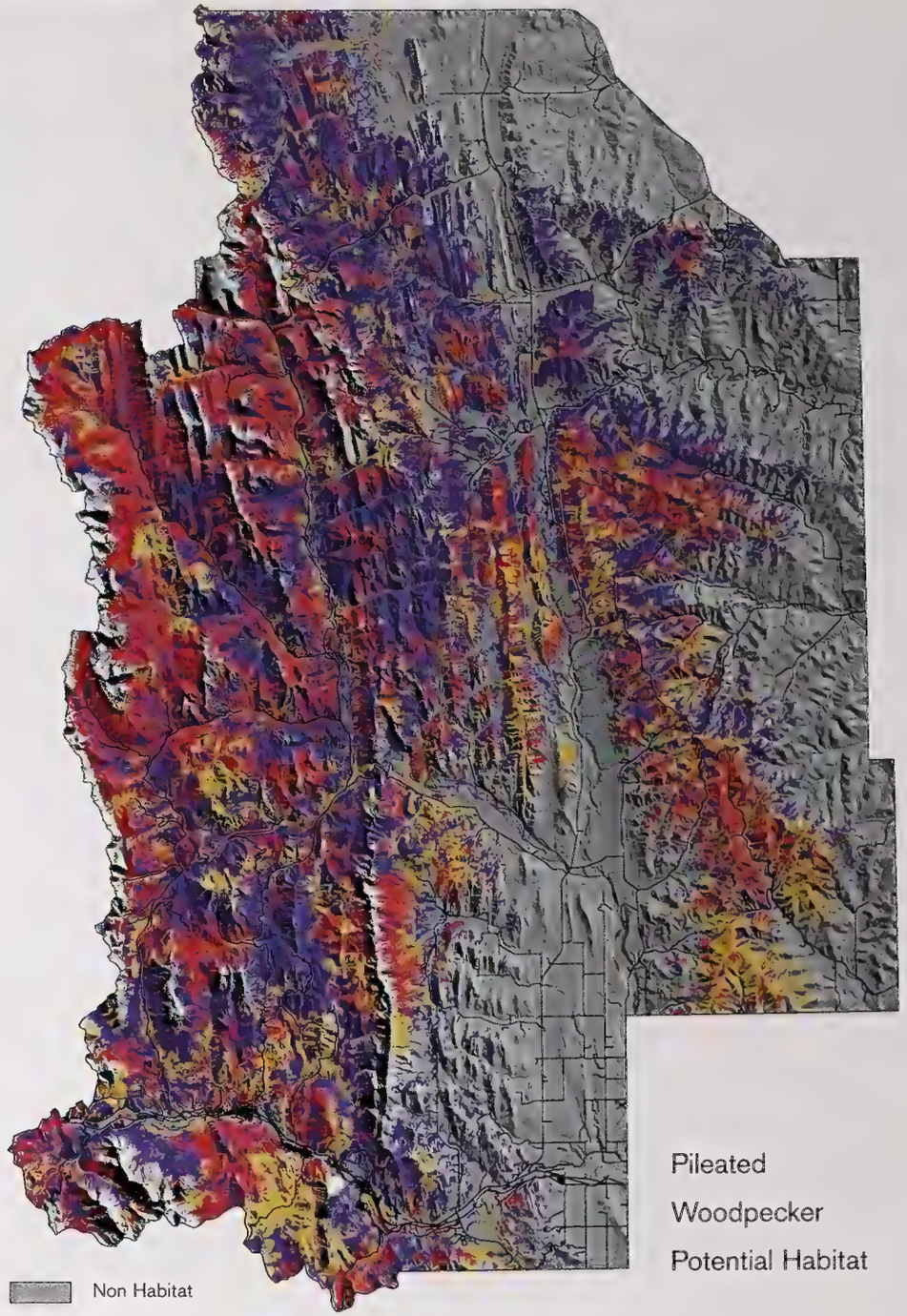


Pileated
Woodpecker
Potential Habitat

Recreation 20



Recreation 50



4.1.1.7. BARRED OWL

(Strix varia)

The Barred Owl is a secondary cavity nester found in dense, mature, old growth, mixedwood or coniferous forests; especially those located near lakes, streams, swamps or marshes (Godfrey, 1986). They may also nest in a deserted nest of hawks or crows (Godfrey, 1986). The barred owls prefer patches with interiors and require stands that are sufficiently mature to provide numerous nesting and roosting hollows (Craighead, 1969).

An important element in managing habitat for the barred owl is to ensure the long–term health of the riparian zones and reserve stands. Maintenance of residual islands and snags within clearcuts is important. Large patches of old growth stands are of particular importance.

The primary inputs to the barred owl model are canopy closure, diameter of trees, ecosite phase as well as access and human use. Deciduous trees with diameters greater than or equal to 35 cm were identified as being preferred nest sites. Spruce and fir are desirable in barred owl habitat. Barred owls are patch interior species and lands within 200 m of an opening are of lesser value. Proximity to human uses also reduces the value of habitat.

The Disturbance Scenario has a large effect on all but the highest quality habitats primarily through loss of large diameter trees. The Trend and Fibre Scenarios both result in a decline in overall barred owl habitat. The Preservation and Recreation Scenarios, on the other hand, result in maintenance of the area of lowest quality habitat and an increase in the area of moderate and high quality habitat. As a result of less harvesting, there are larger diameter trees in the landscape and a greater number of large patches, all of which benefit barred owls.

Figure 69. Area of Potential Barred Owl Habitat – All Scenarios

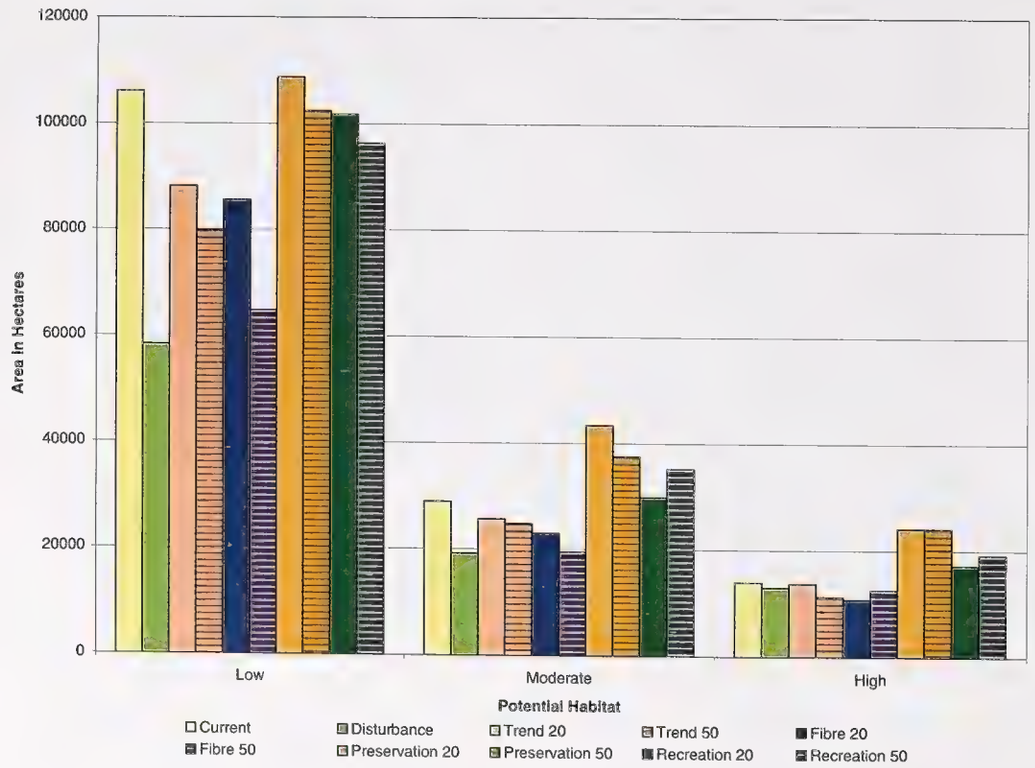
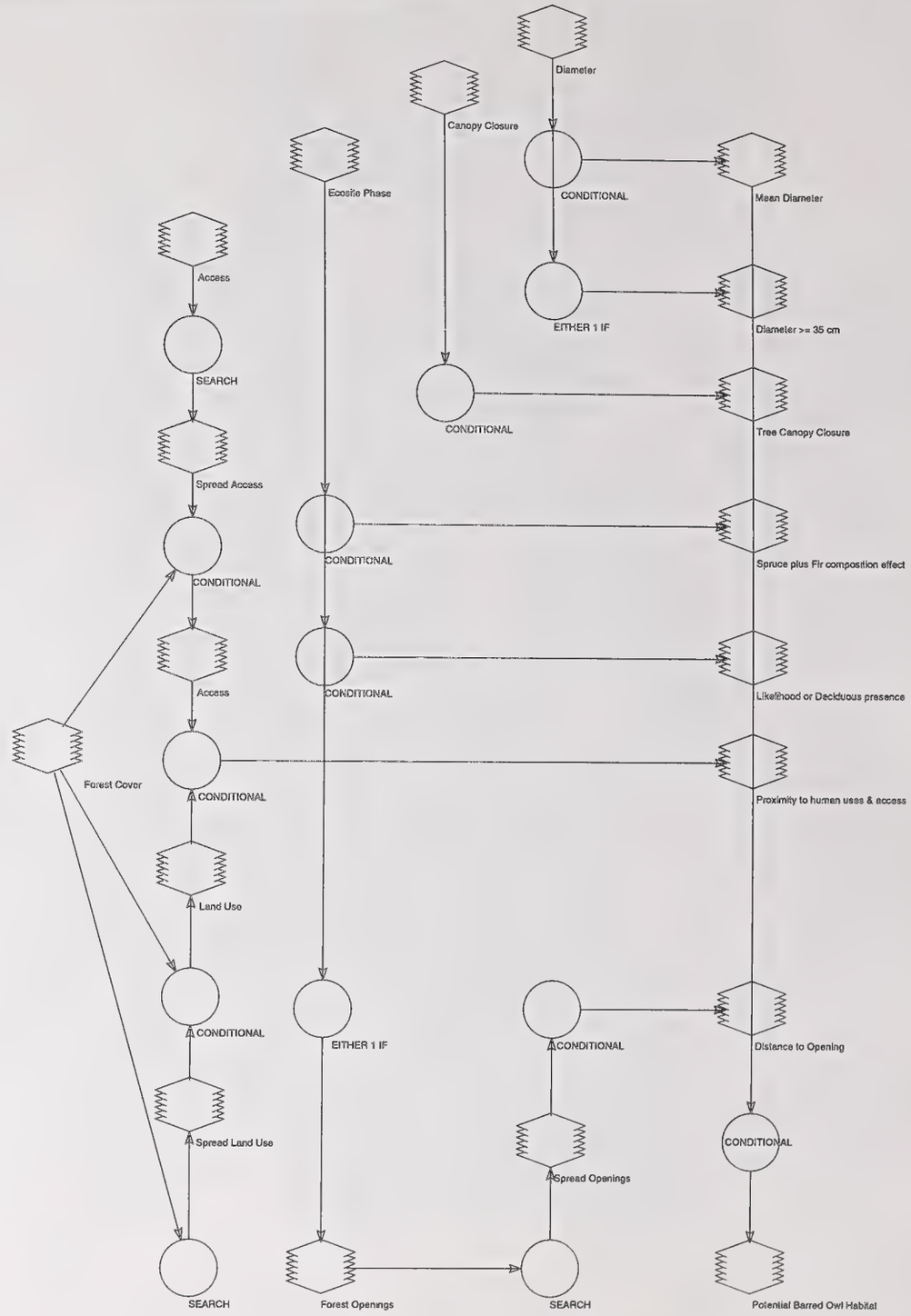
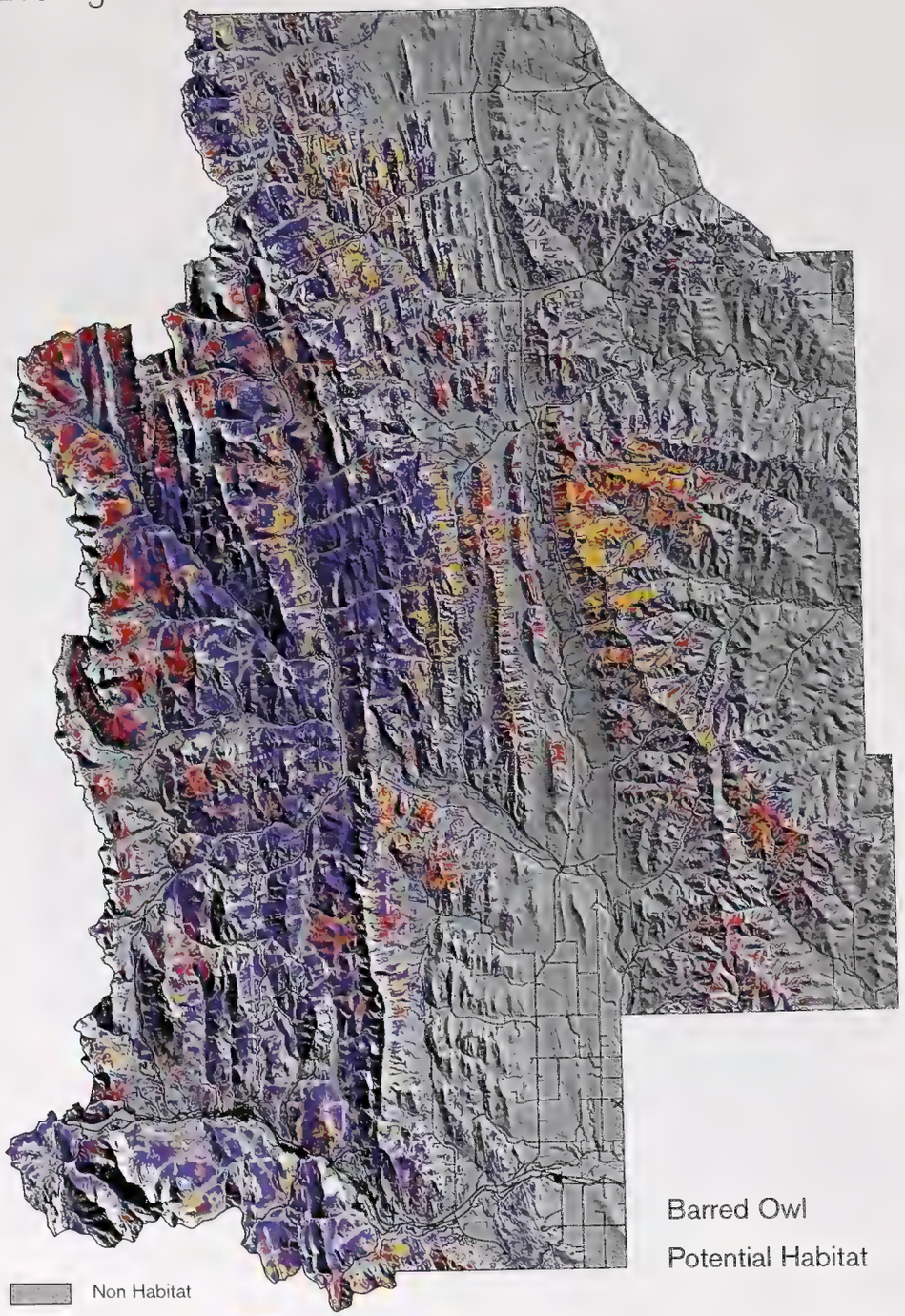


Figure 70. Potential Barred Owl Habitat Graphical Model

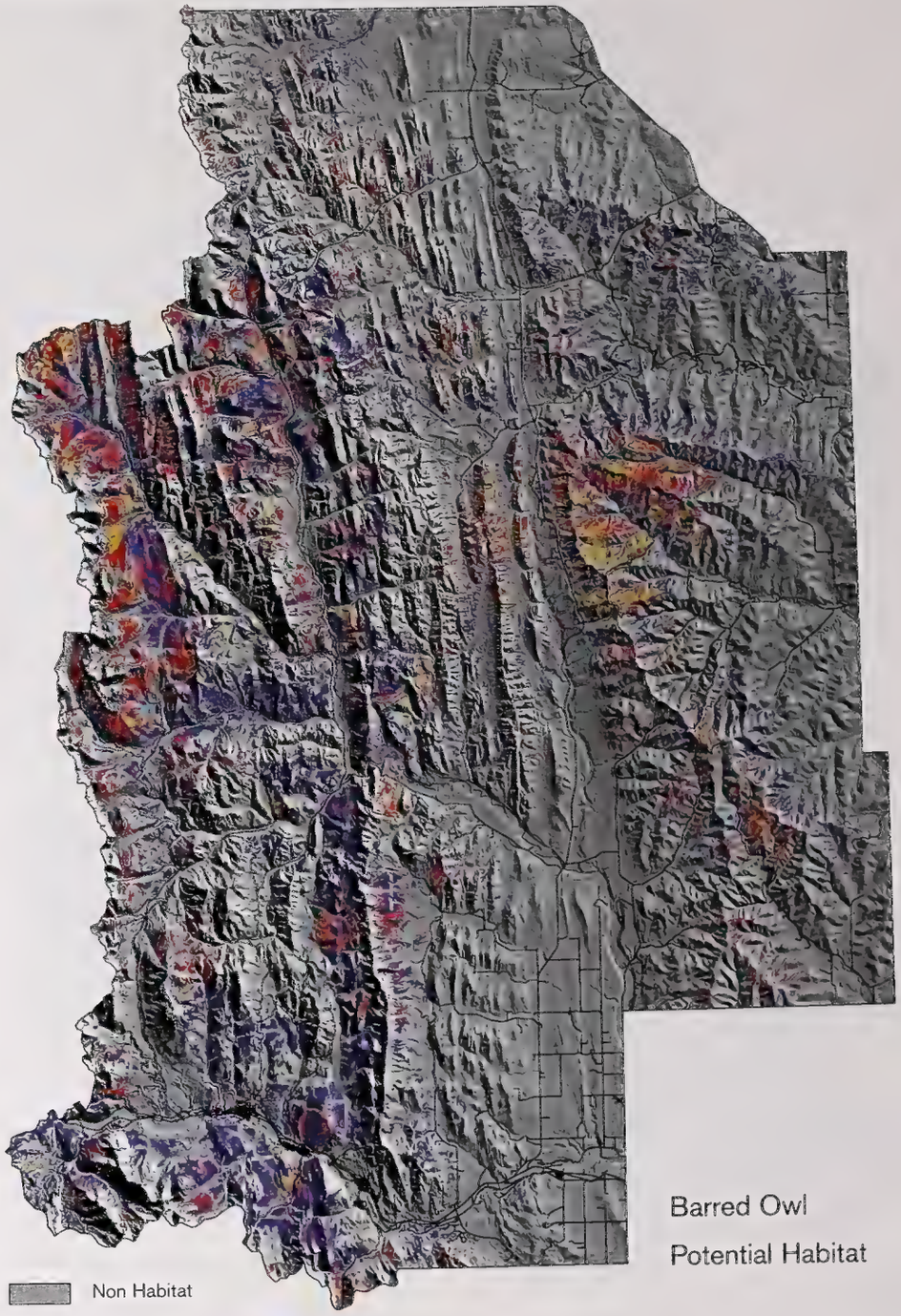


Existing



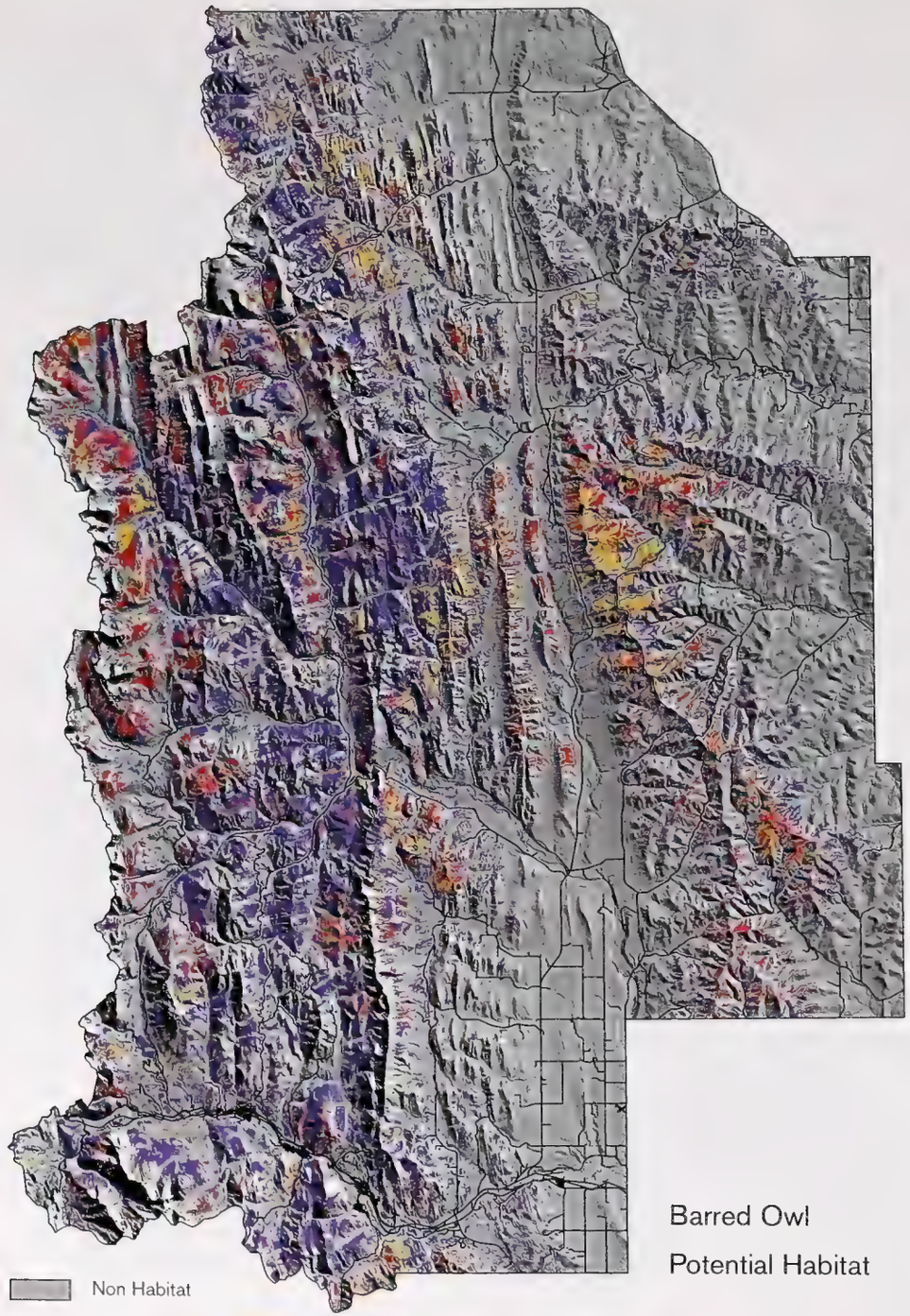
Barred Owl
Potential Habitat

Disturbance

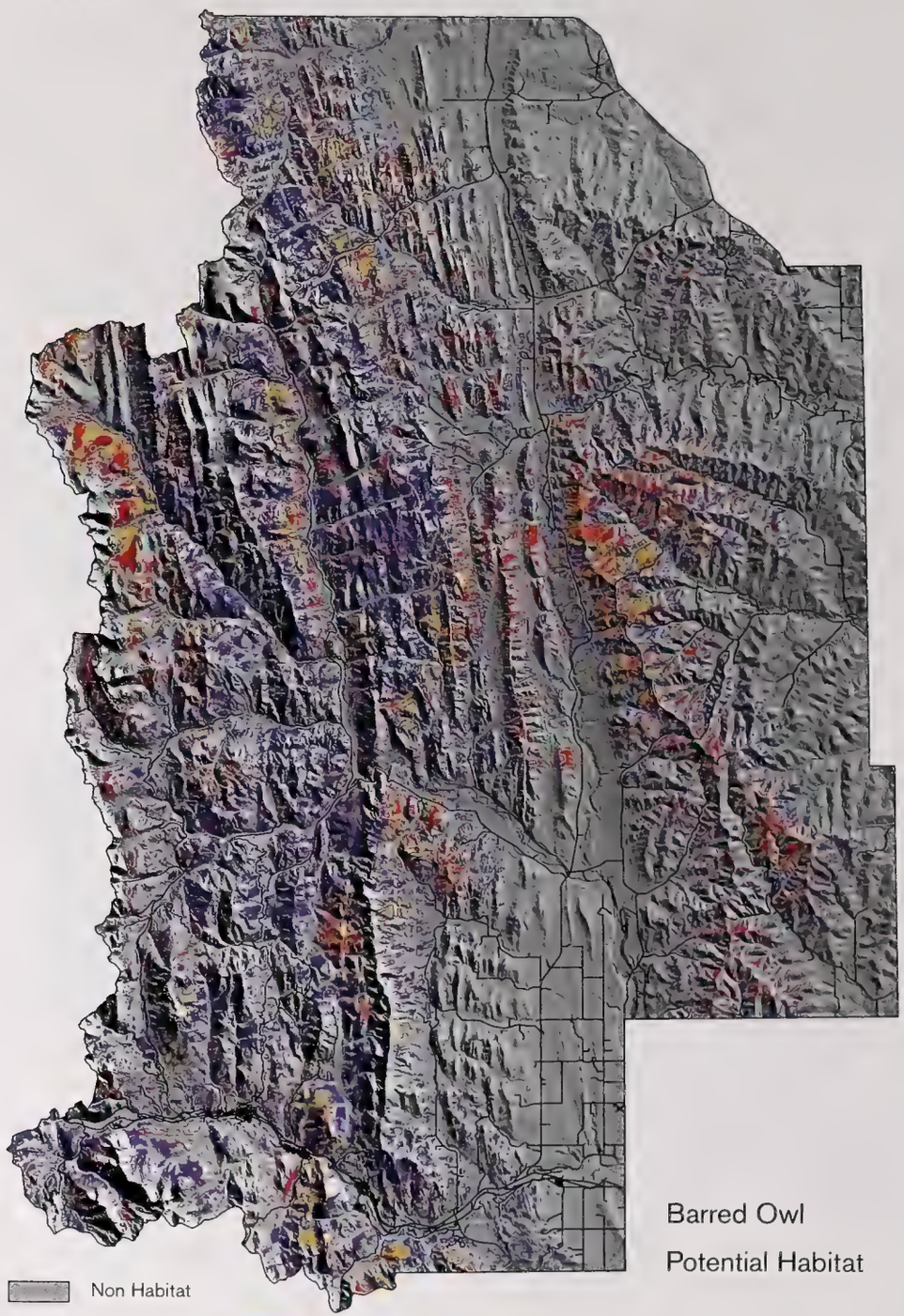


Barred Owl
Potential Habitat

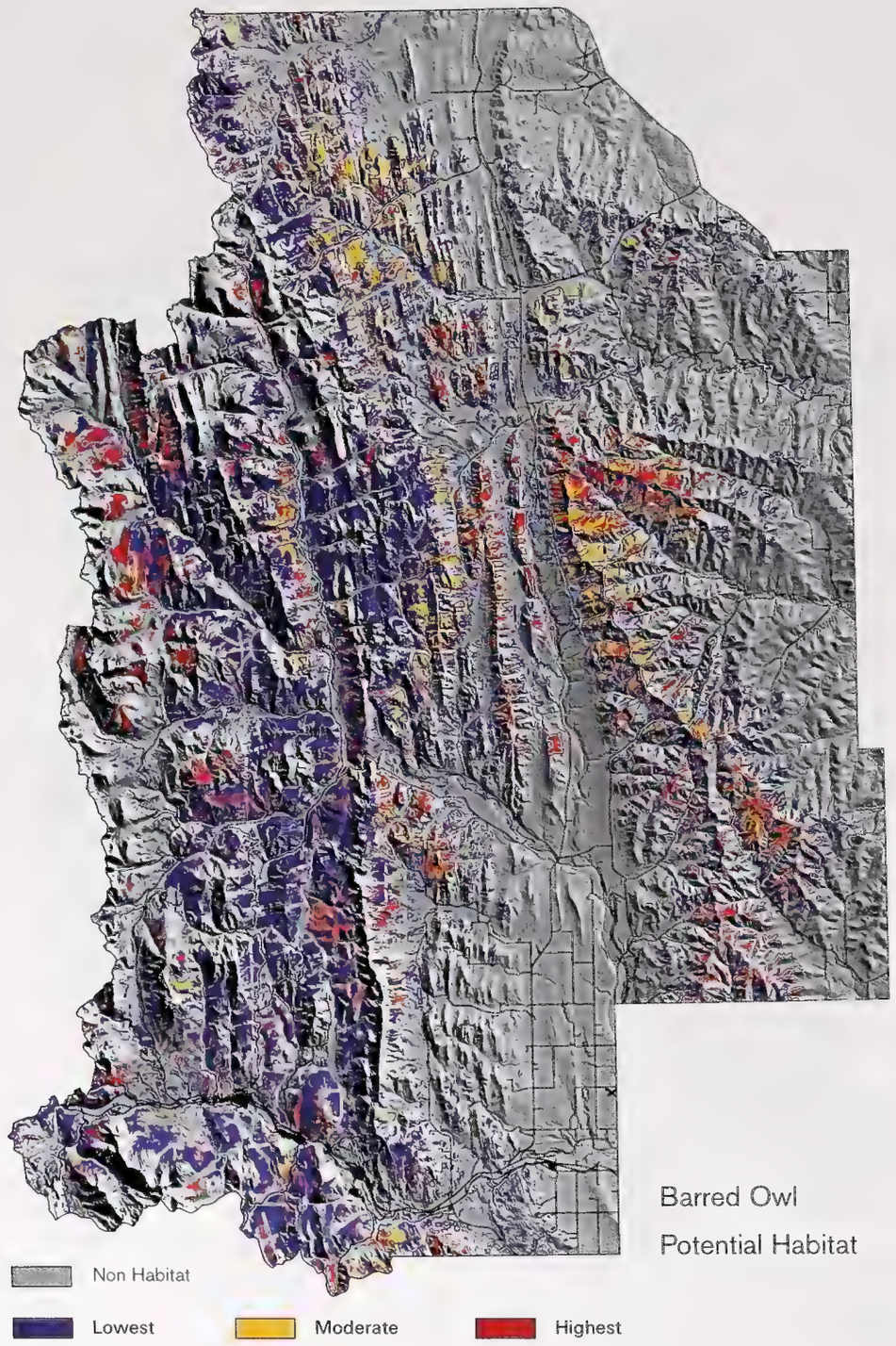
Trend 20



Trend 50

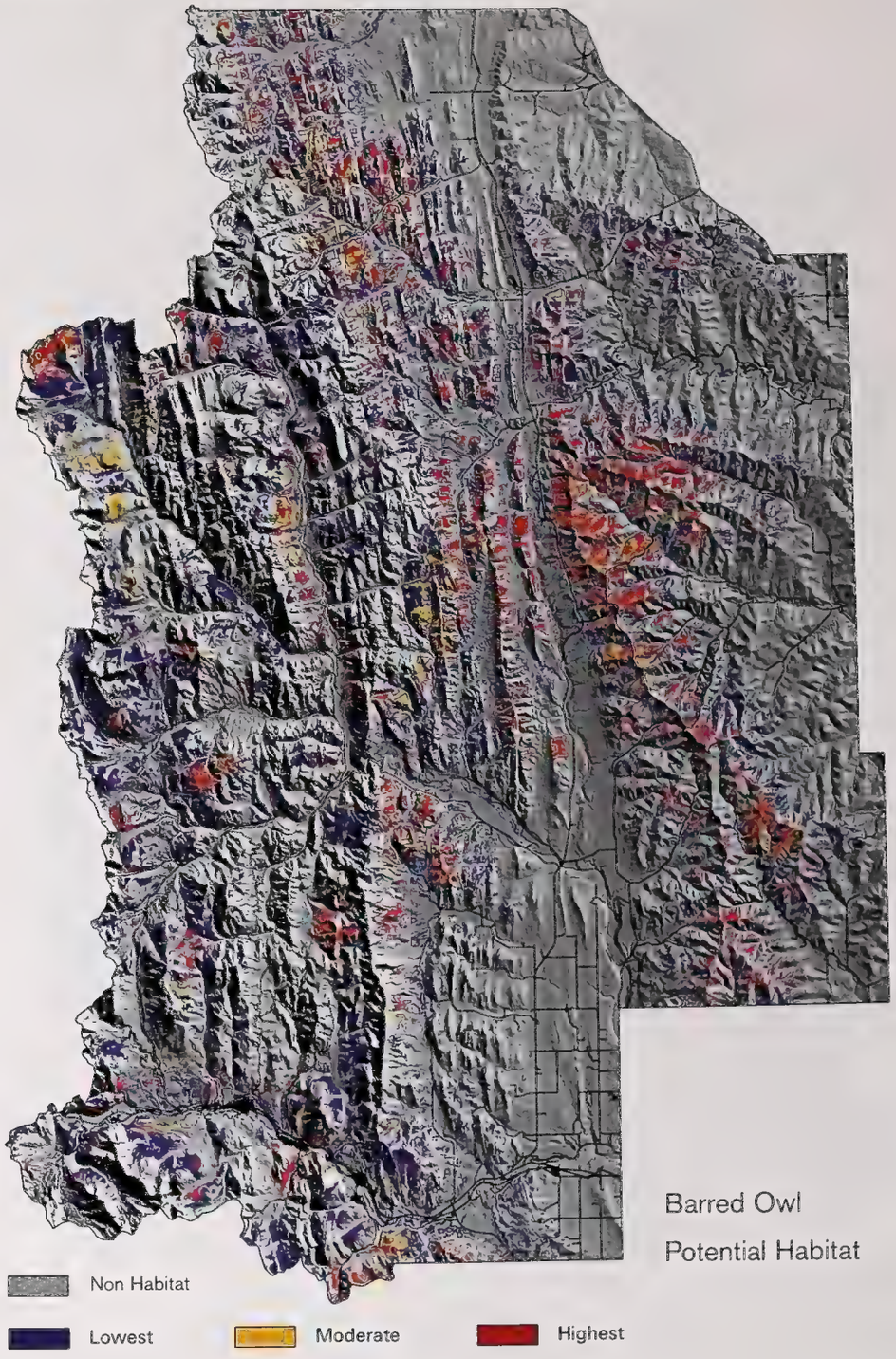


Fibre 20



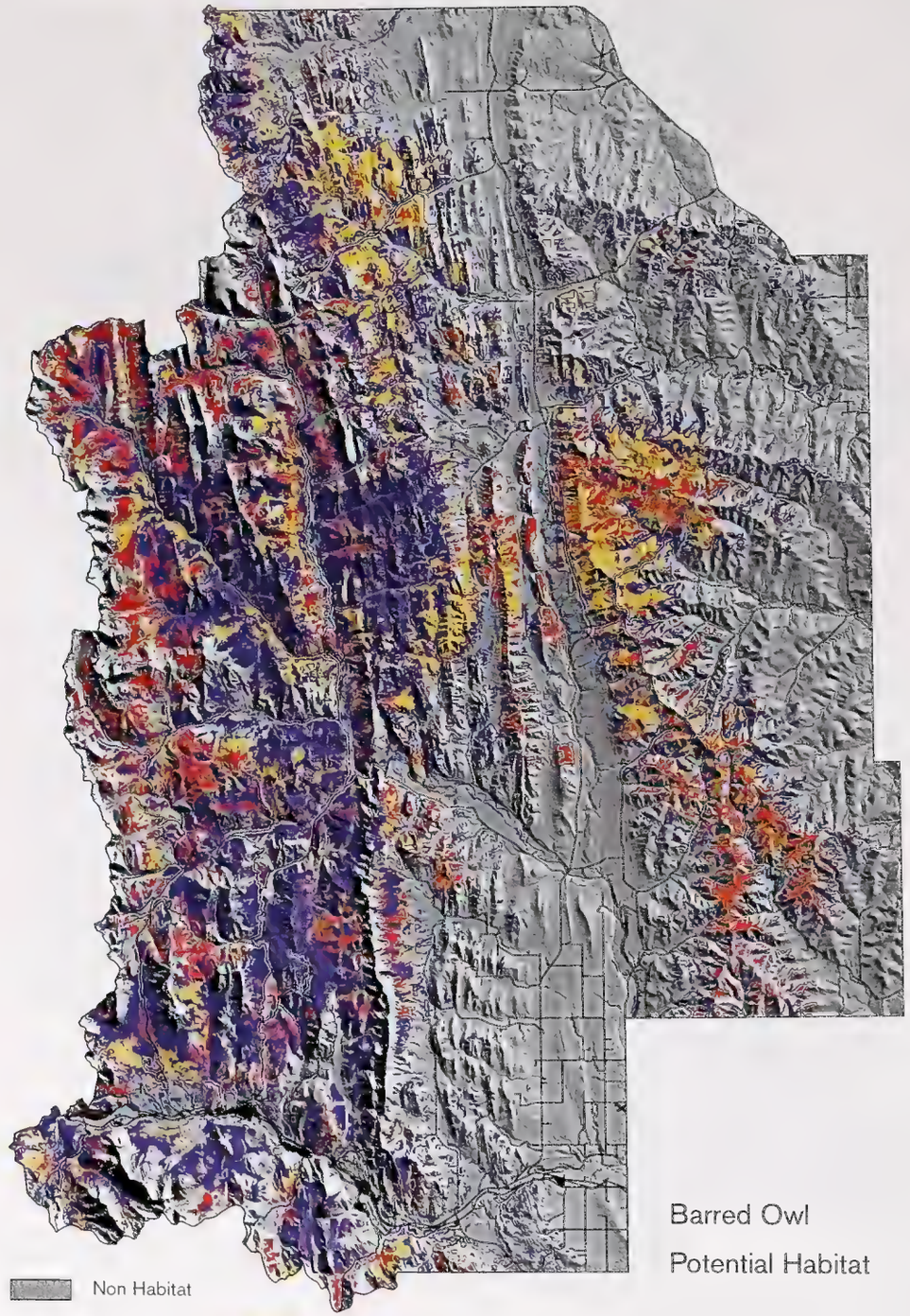
Barred Owl
Potential Habitat

Fibre 50



Barred Owl
Potential Habitat

Preservation 20



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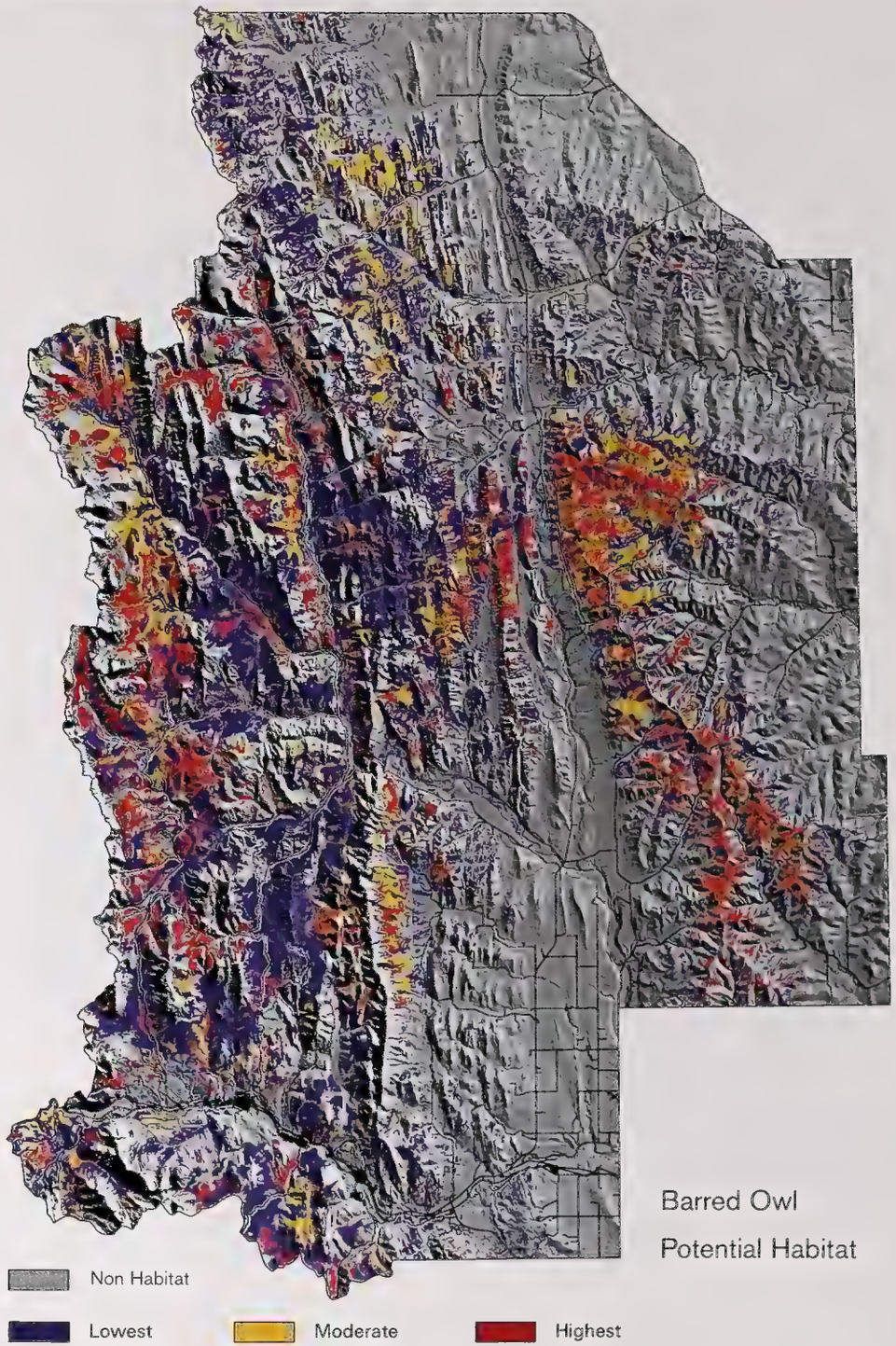
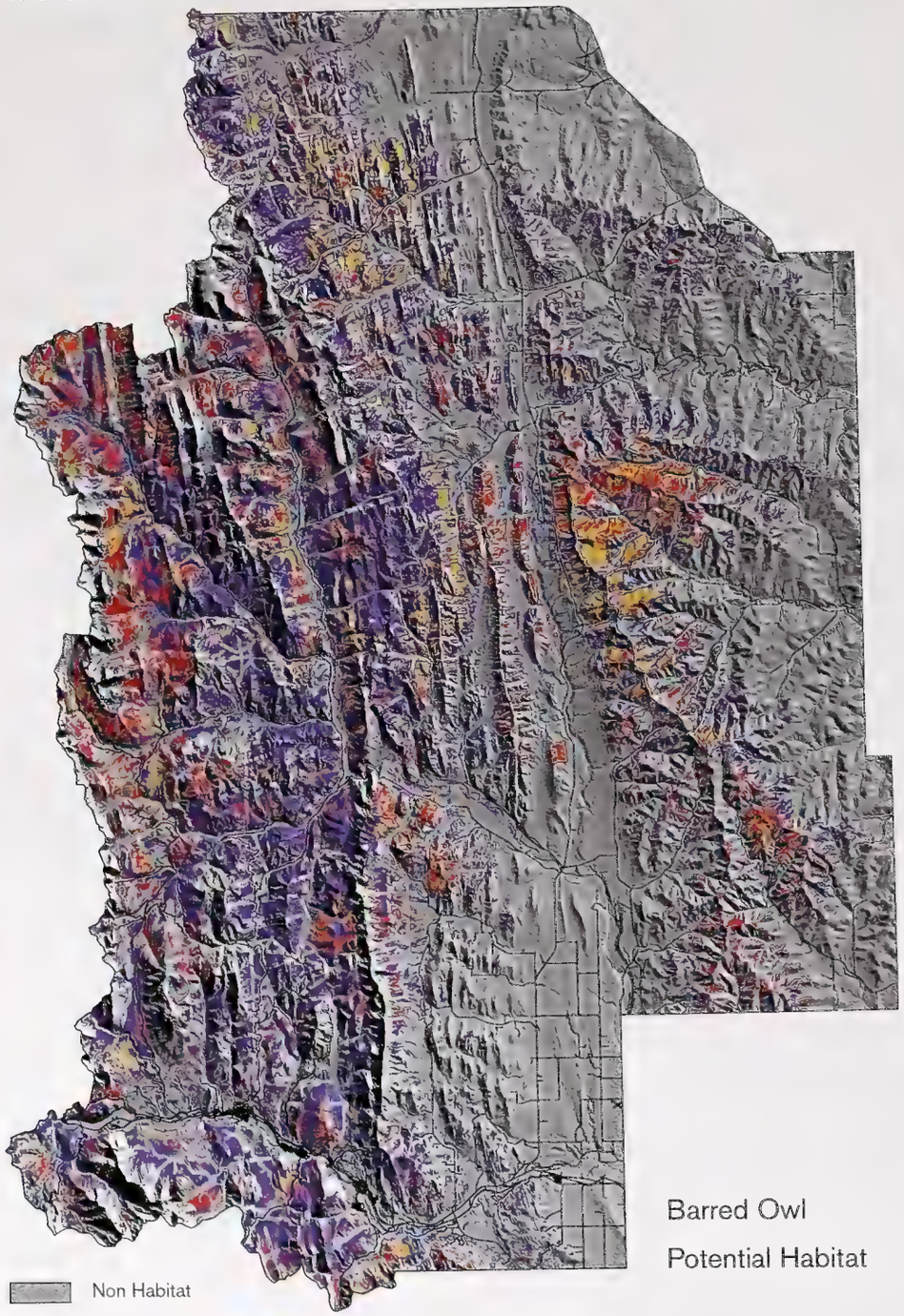
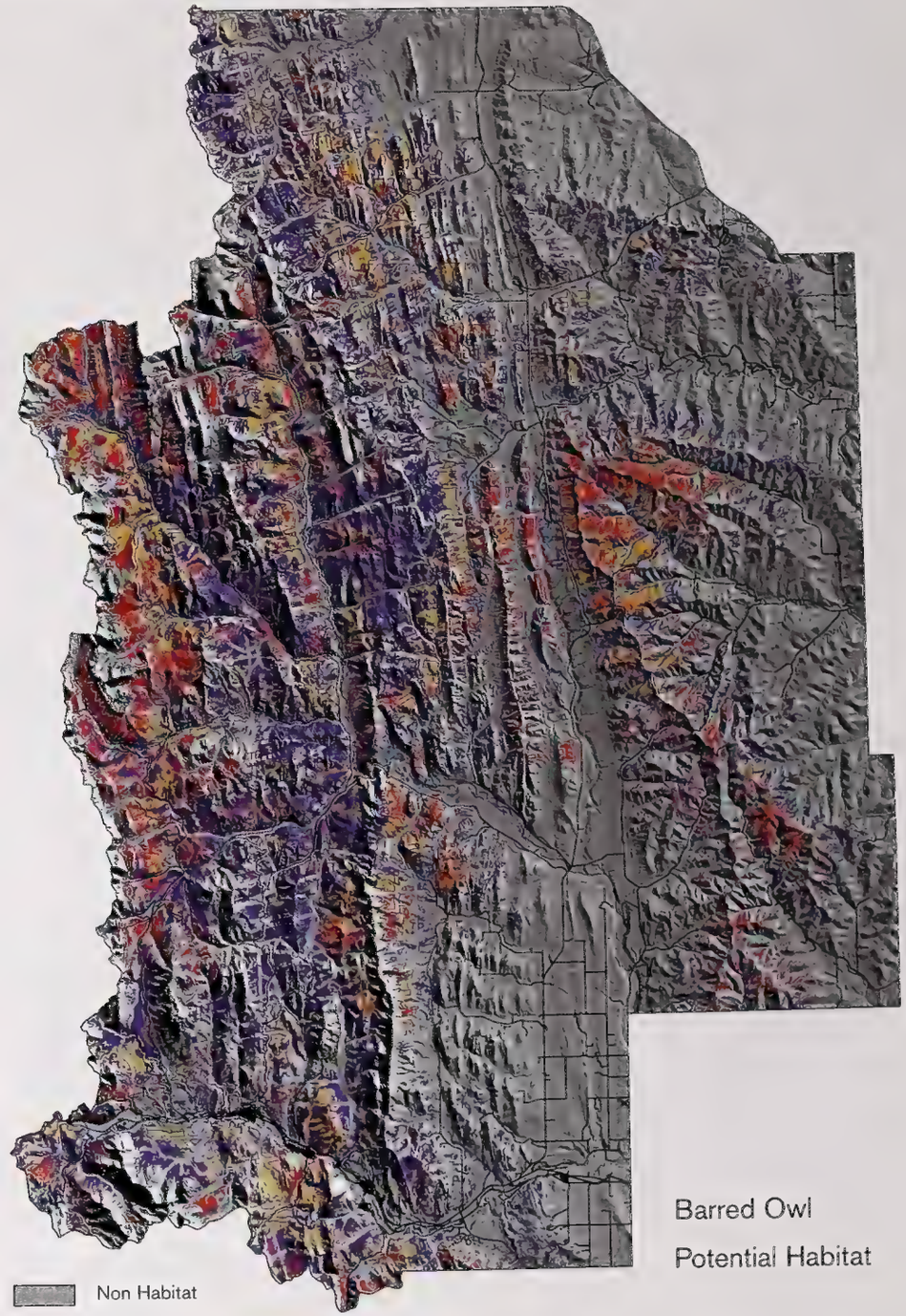


Recreation 20



Recreation 50

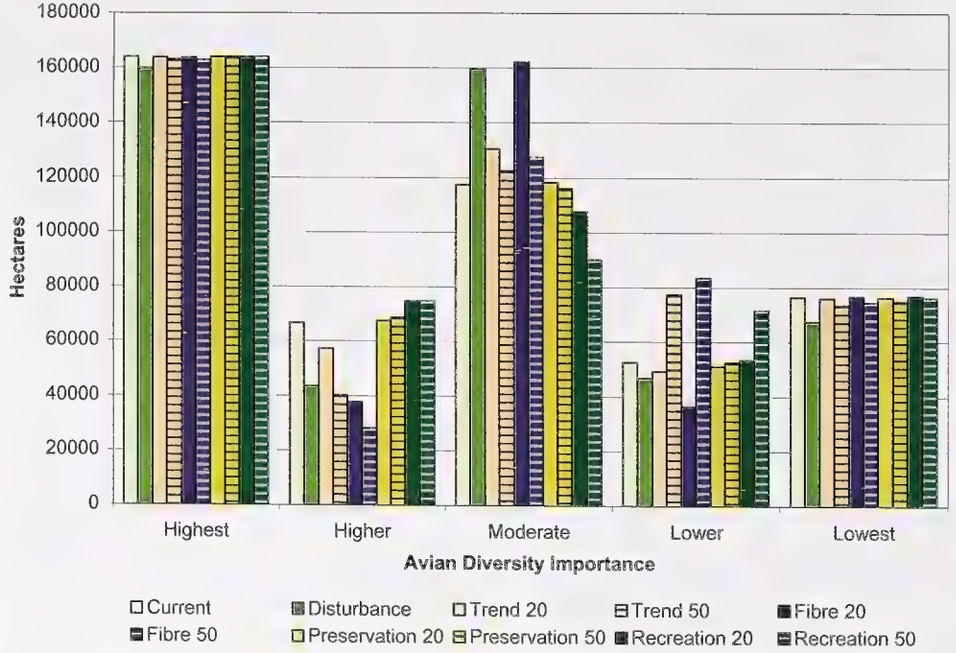


4.1.2. AVIAN DIVERSITY VALUE

Avian diversity has been selected for modelling in order to assess the impact of the scenarios on a suite of species and to augment the single species assessment. The relationship of vertebrates to habitat types is well known for many species but is incomplete for others. A direct correlation between all bird species known to be in the area with vegetation types was not possible. A sampling program and ranking system was, therefore, established.

Field sampling of vegetation cover types was carried out in the summers of 1997 and 1998. The number of singing and observed birds was measured for the land cover types. An equivalency was established between forest cover types and ecosite phase in order to allow for modelling of the future scenarios which are described only in terms of ecosite phase.

Figure 71. Area of Avian Diversity – All Scenarios



Definition of Diversity Value

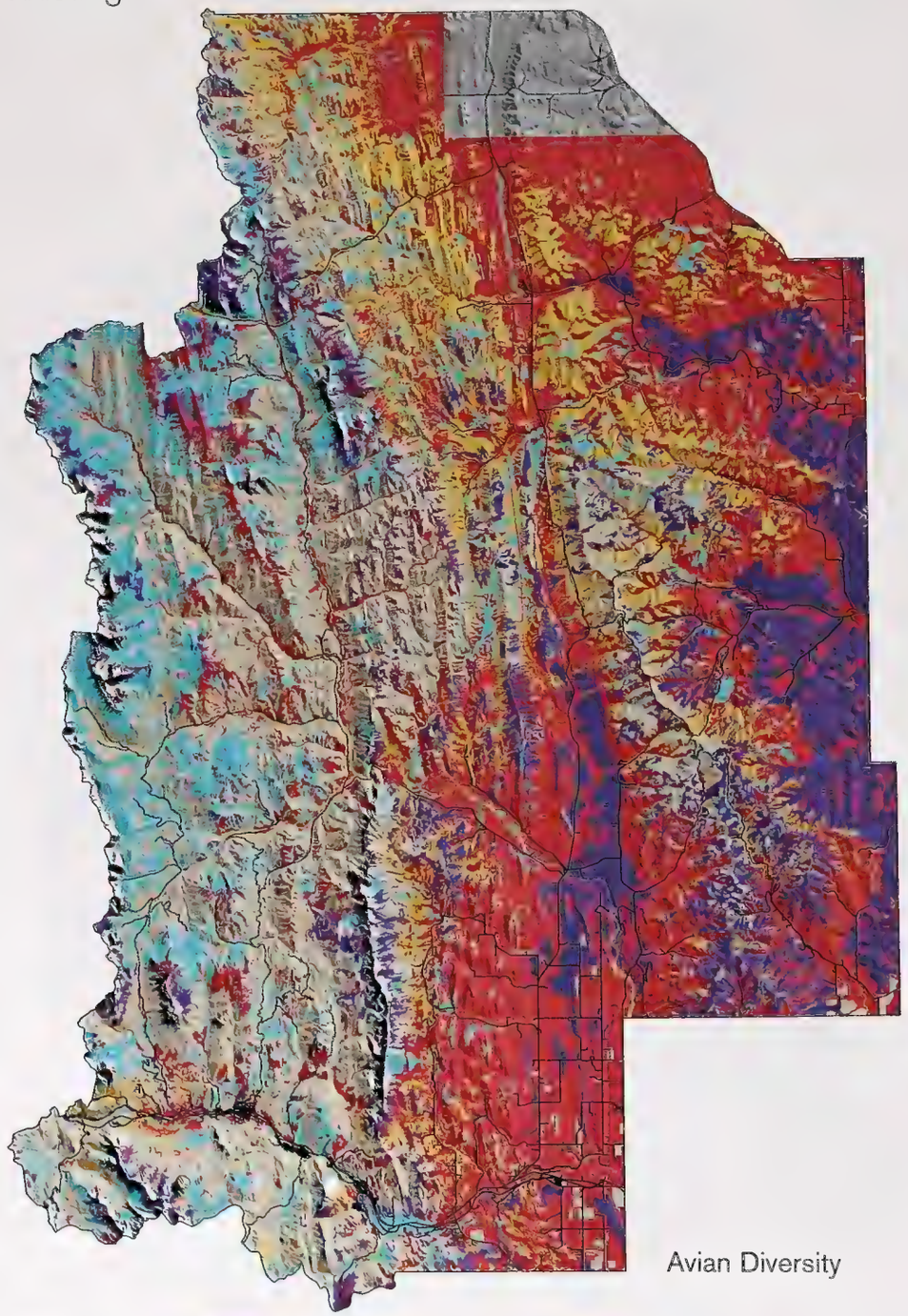
The model of avian diversity value is based on analysis of the field data by Shank (1998). It is based on the assumption that the biodiversity at any particular place is valued equally within the context of the local, regional and provincial scales. At the local scale, the estimated number of species present in a land cover type defines the diversity value of a cover type. This was calculated using the program "EstimateS" (Colwell 1997). At the regional scale, biodiversity value of a land cover type is measured as a function of the number of species found in the type that are not found in other types in the study area. At the provincial scale, biodiversity is quantified as the number of Yellow, Red or Blue listed species detected in the land cover type. Ranks were assigned for each scale. Overall biodiversity value is then determined as the mean ranking produced by the three spatial analyses.

The impact of the scenarios indicated little change in the area of the highest and lowest diversity categories under all scenarios. However, high and moderate categories did change substantially. The Disturbance Scenario resulted in a shift from the higher to the moderate category. The Trend also caused a similar decline in diversity that worsened over time. The Fibre Scenario caused the greatest loss of diversity with the area in the higher category approximately half that of the current conditions. The Preservation and Recreation Scenarios both show a slight increase in area of the higher categories. The Recreation Scenario results in increases in the lower category over time. This may be due to the lack of disturbance as neither burning nor substantial logging is occurring under the Recreation Scenario. Loss of mixedwoods due to stand conversion (due to both natural succession and the current preference for regeneration to coniferous) has a large impact on avian diversity.

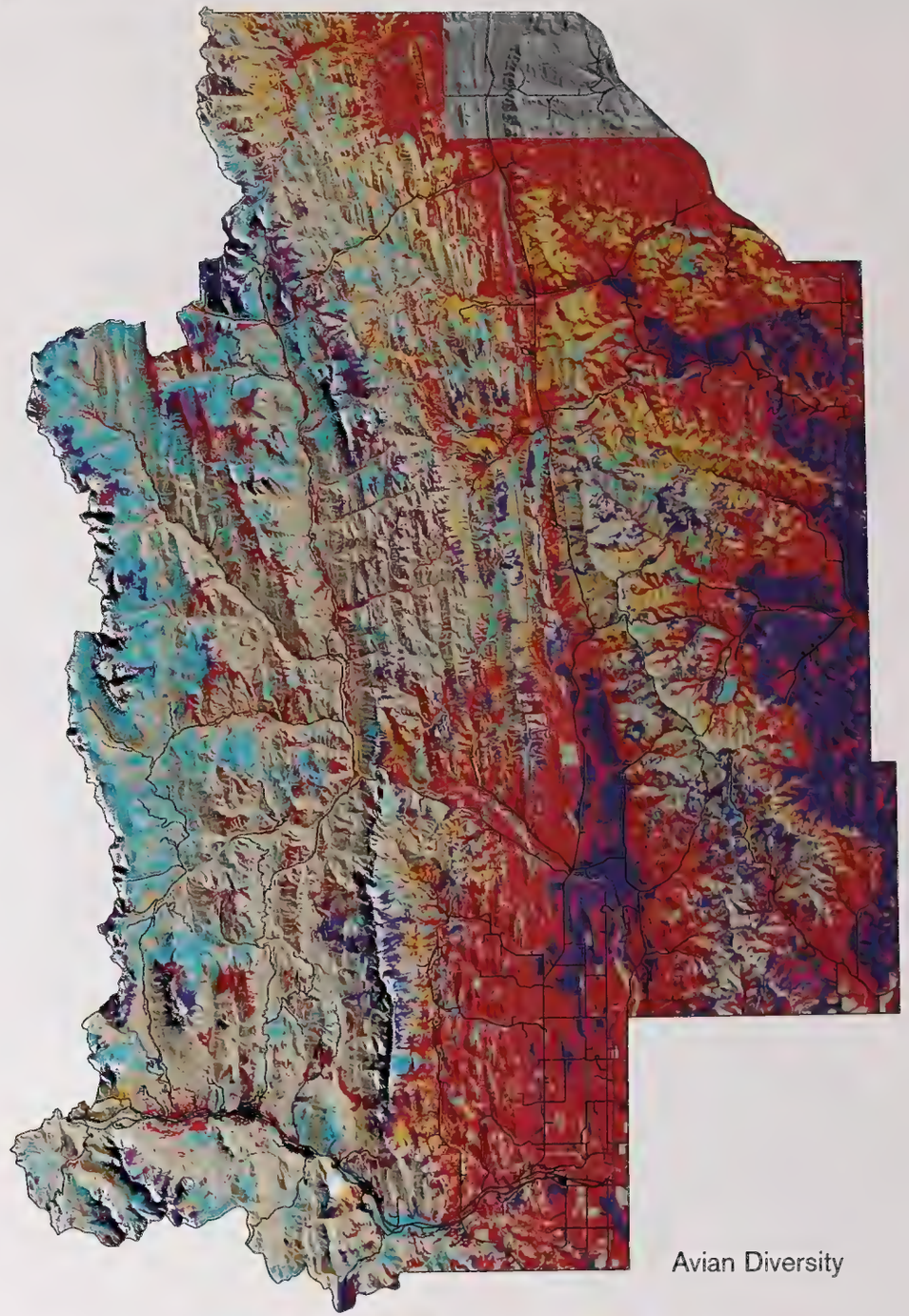
Table 4. Overall Avian Diversity Score and Ranking

Cover Type	Rank
Balsam Poplar	1
Aspen Mixedwood	2
Shrub Meadow Open Dry	3
Grassland Mesic	3
Douglas Fir Mixedwood	3
Perennial Crops	6
Shrub Meadow Closed Mesic	7
Spruce Mixedwood	8
Aspen	9
Rough Pasture Open Mesic	10
Subalpine Fir	11
Pine Mixedwood	11
Mixed Conifer (Pine)	13
Spruce Wetland	14
Mixed Conifer (Spruce)	15
Mixed Conifer (Douglas Fir)	16
Herbaceous Clearcuts	16
Whitebark/Limber Pine	16
Rough Pasture Closed Mesic	19
Pine	20
Annual Crops	20
Wet Graminoid	22
Mixed Conifer (Whitebark/Limber Pine)	23
Balsam Poplar Mixedwood	24
Mixed Conifer Fir	25
Spruce	26
Shrub Wetland	27
Rough Pasture Closed Dry	27
Grassland Dry	29
Forb Meadow	30
Mixed Conifer (Larch)	31
Subalpine Fir Mixedwood	32
Douglas Fir	33
Subalpine Larch	34

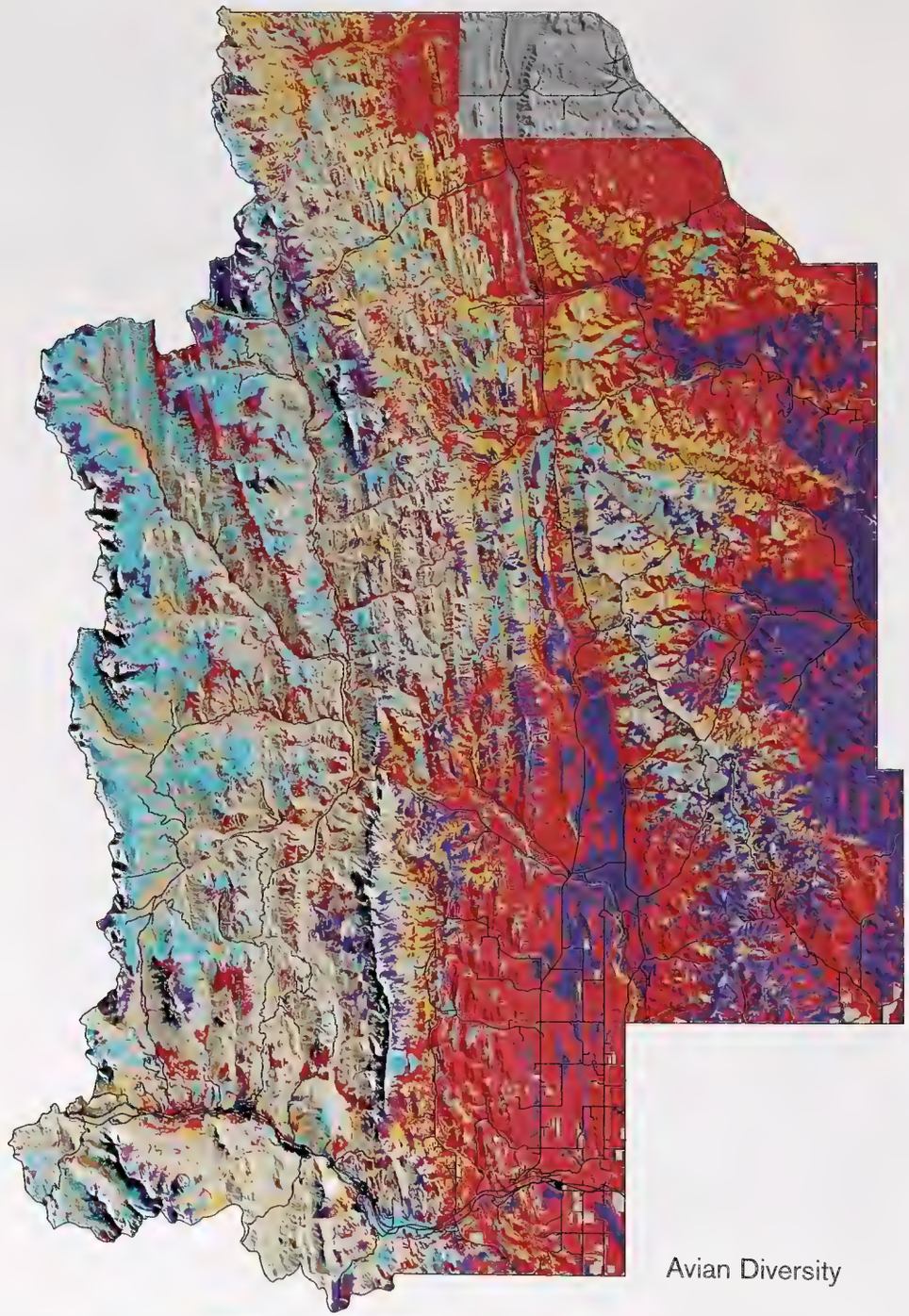
Existing



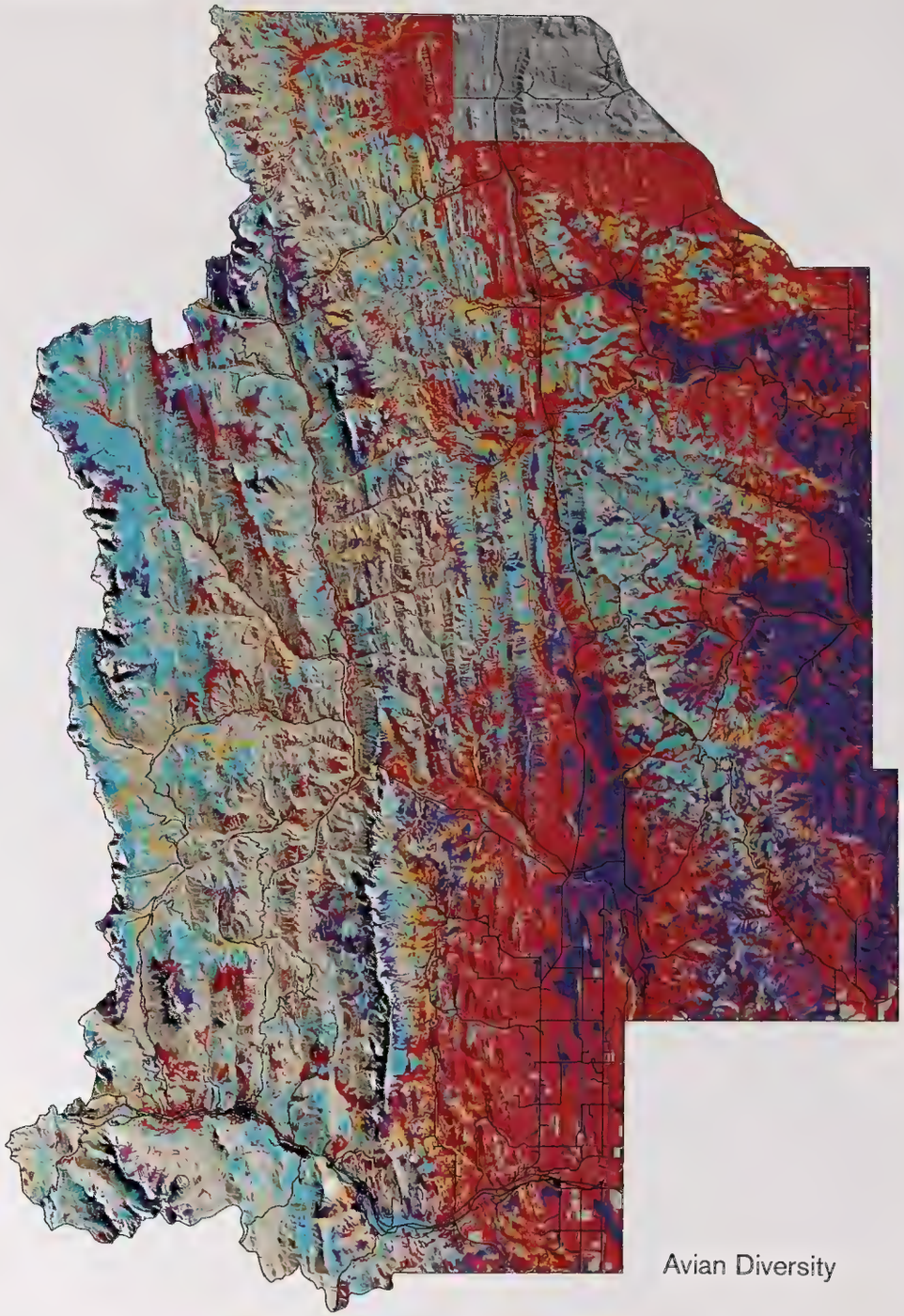
Disturbance



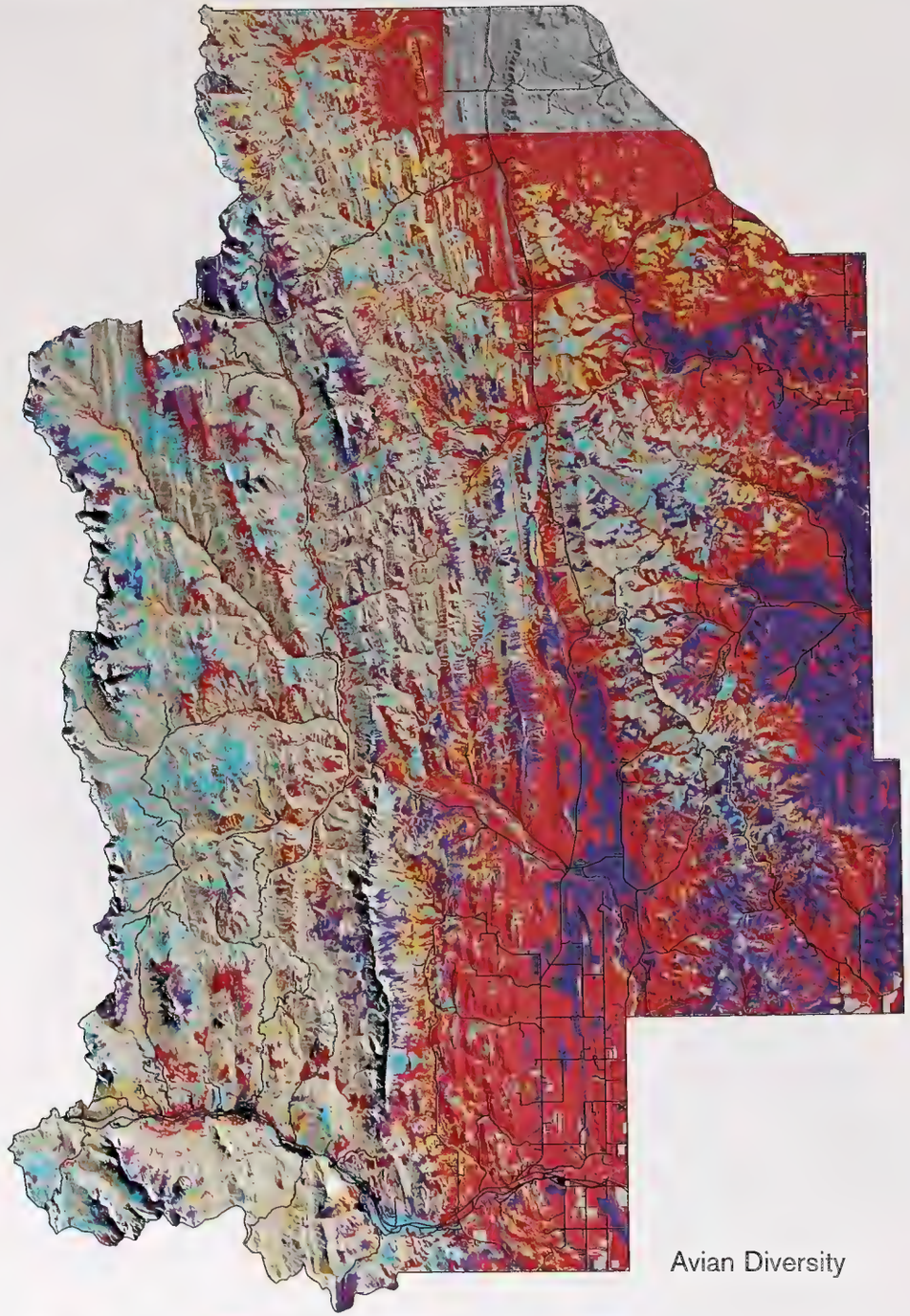
Trend 20



Trend 50



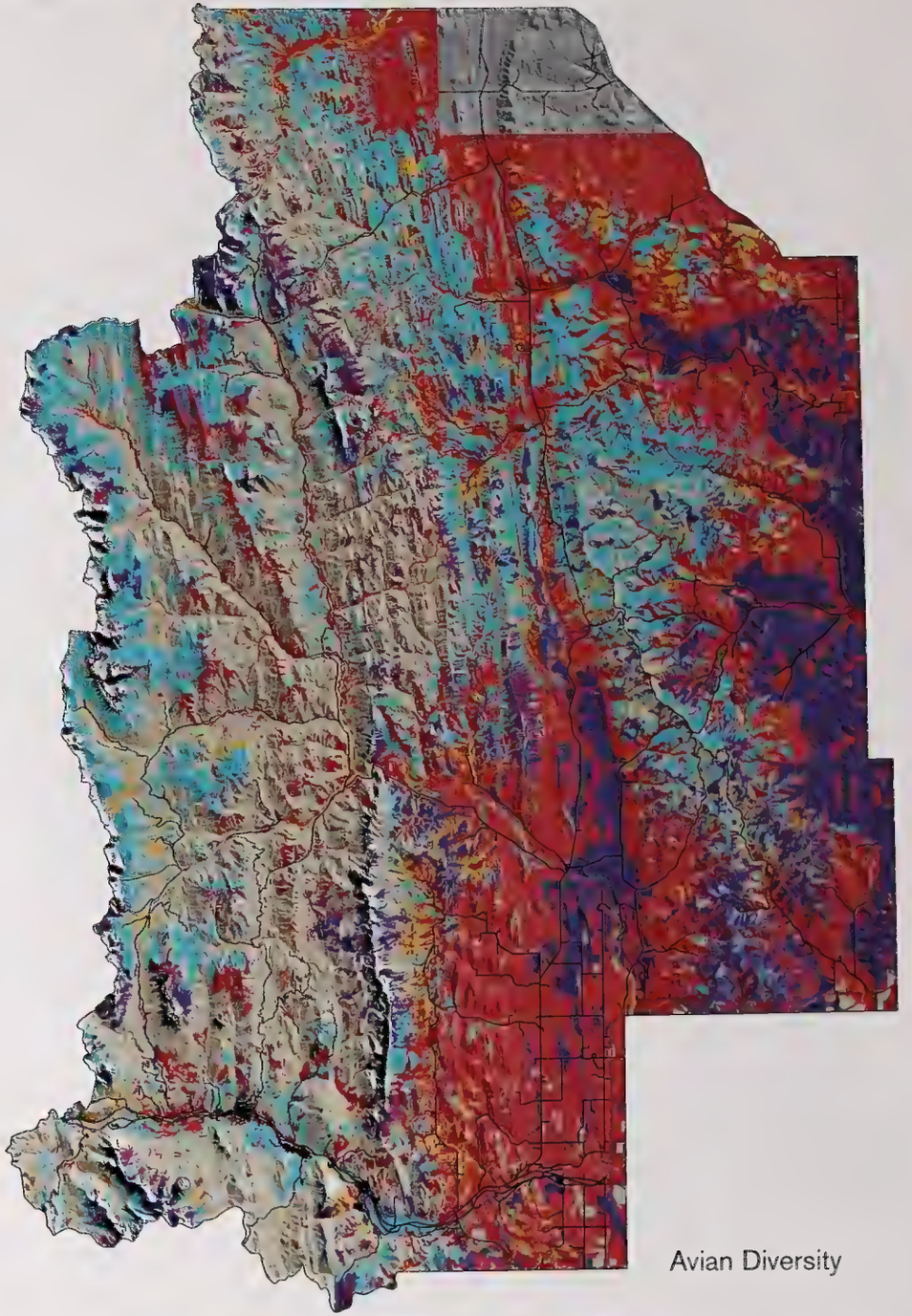
Fibre 20



Avian Diversity

Lowest Lower Moderate Higher Highest

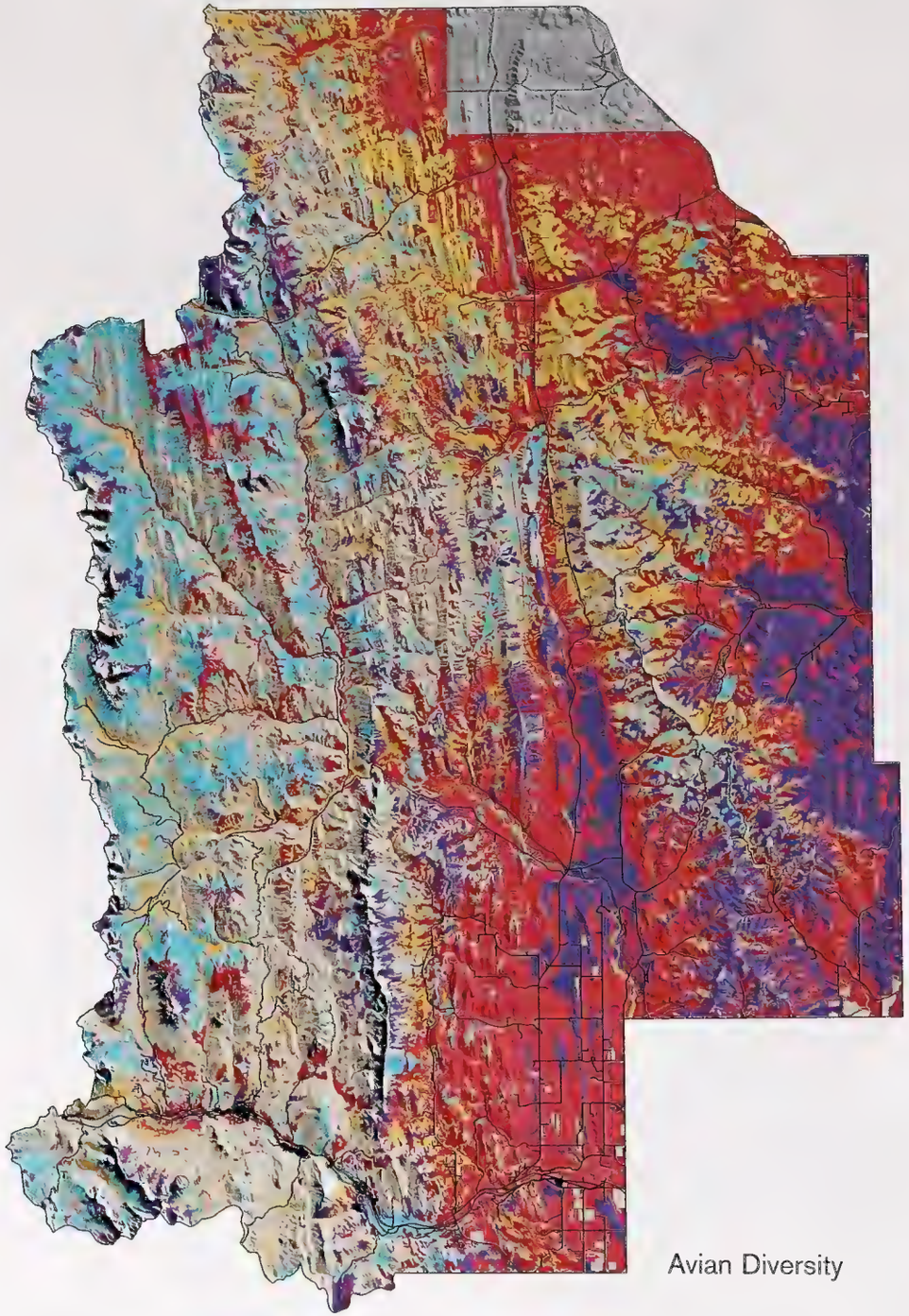
Fibre 50



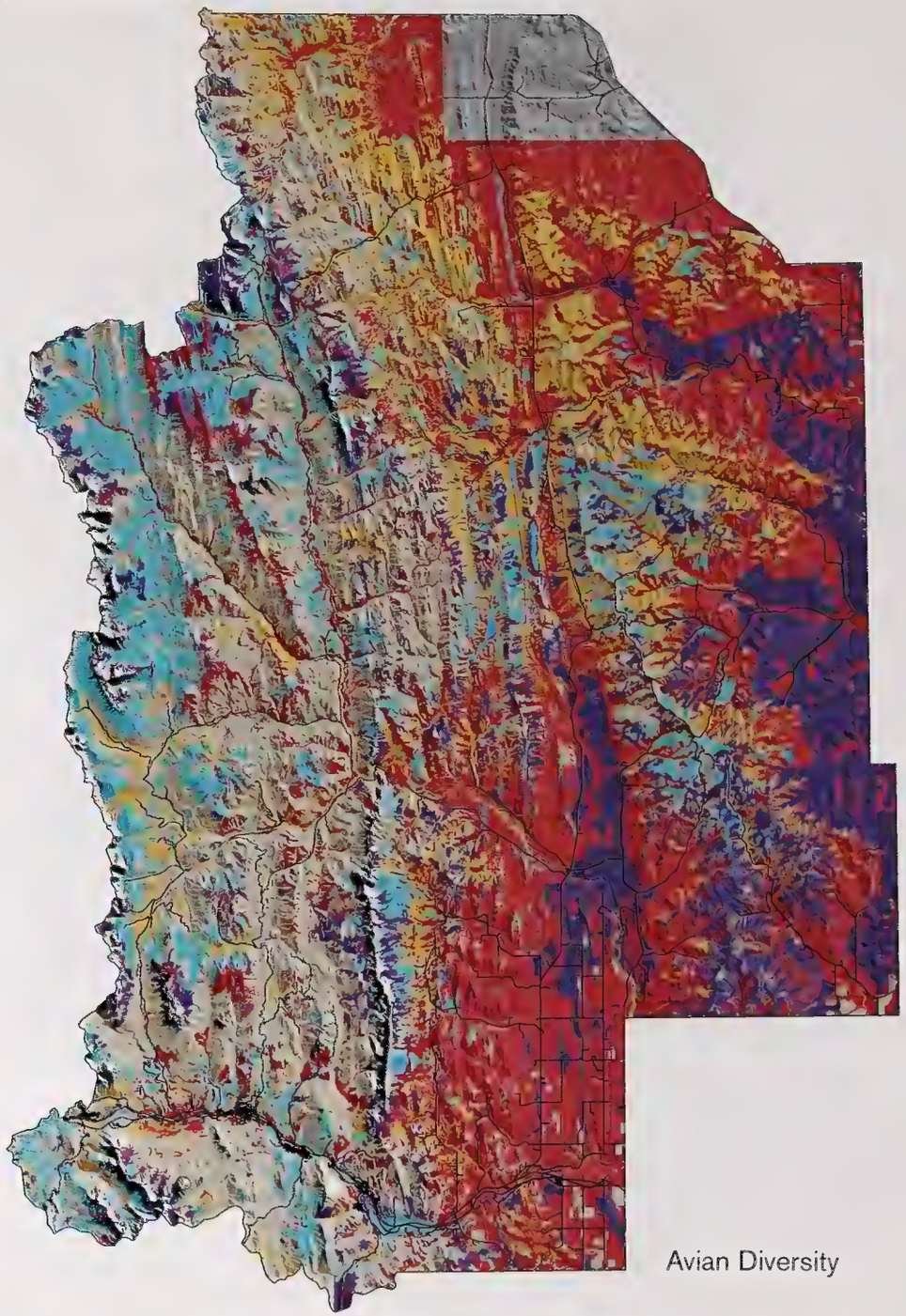
Avian Diversity

Lowest Lower Moderate Higher Highest

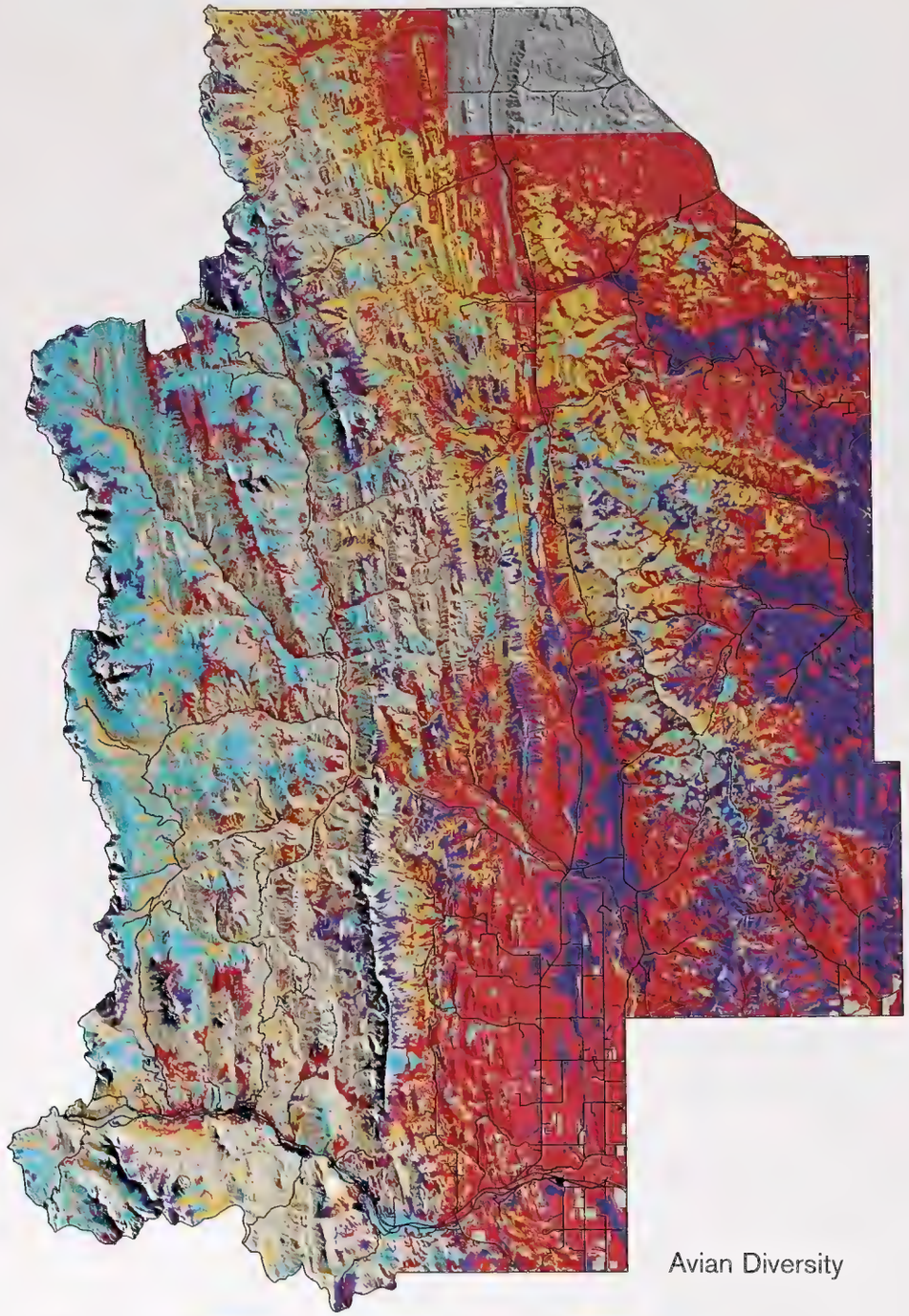
Preservation 20



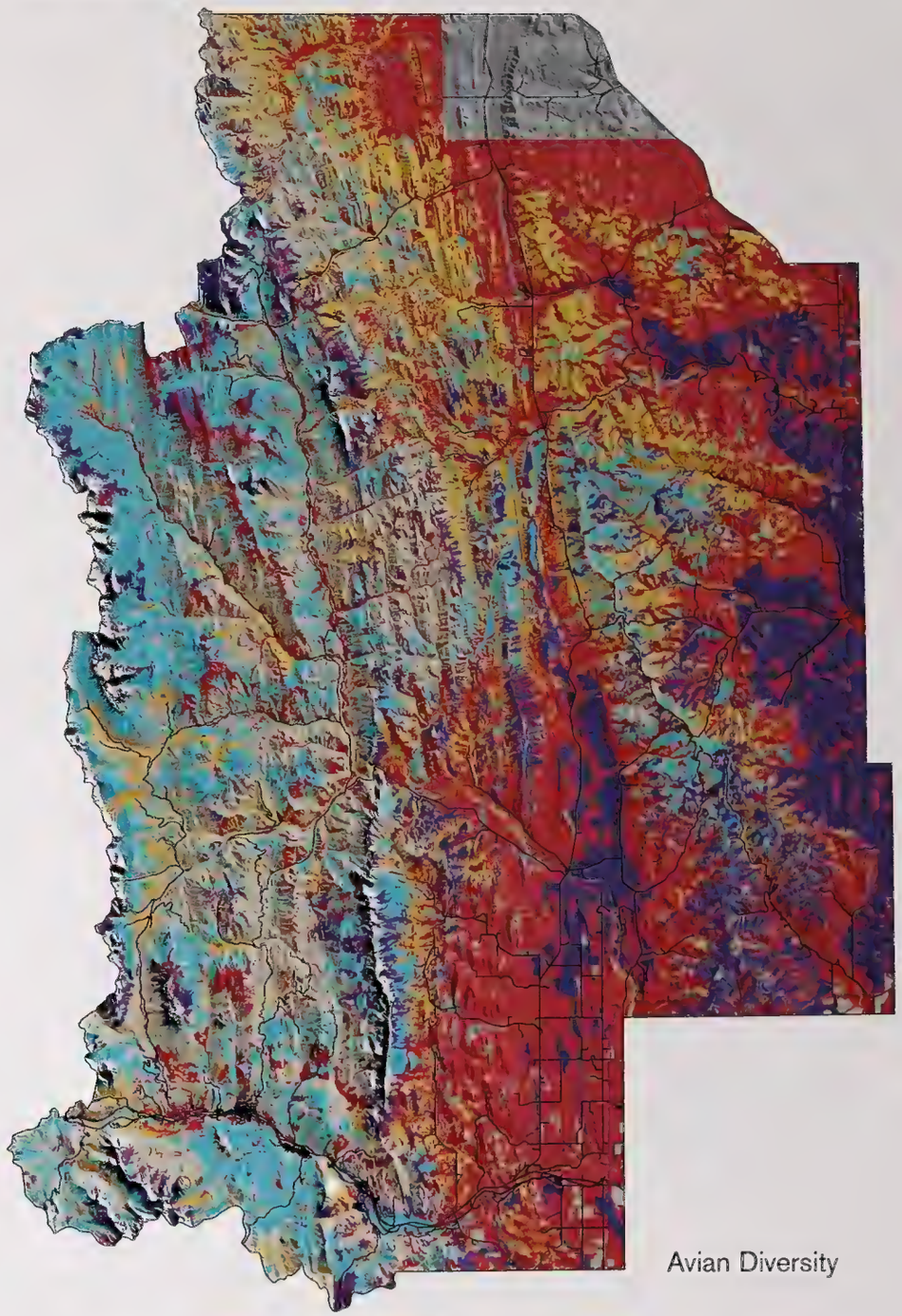
Preservation 50



Recreation 20



Recreation 50



4.1.3. ECOSITE PHASE DIVERSITY

"To keep every cog and wheel is the first precaution of intelligent tinkering" (Aldo Leopold, *Round River* 1953). Therefore, the maintenance of current ecosite phase diversity at both the regional and individual landscape scale is a prudent objective for land managers. The existing ecosite phase distribution for both the region and individual landscapes is found in the Disturbance and Pattern report.

The various types of ecosite phases represent unique combinations of physiography and vegetation conditions which provide a variety of habitats for numerous species. Many species require different types of habitats within a local area. This interspersion of habitats is one measure of the general configuration of the landscape that provides a useful check of the divergence of future scenarios from the existing conditions. While direct correlation between species diversity and the diversity of habitats in the local area is difficult to make, it is of interest to note that in most of the areas of high avian diversity, the ecosite phase diversity tends to be either high or moderate.

In order to assess the interspersion, a map of ecosite phase diversity was created by focal scanning within a 1 kilometer moving circular window for the number of different ecosite phases. The map indicates "hotspots" of potential biodiversity and clearly indicates that the Whaleback, Saddle Mountain, North Livingstone and Horseshoe Parkland LMUs have the highest potential diversity in the region. Saddle Mountain is the highest of these. (Refer to LMU map, page 11.)

As the stands undergo succession or transition to other ecosite phase types through harvesting, there are changes in local diversity. The Disturbance Scenario causes a slight decrease in areas of high diversity, but the impact overall is minor. The Trend Scenario reduces the area of high diversity while increasing the moderate category. All other scenarios display very little difference in total areas in the various categories. However, there are spatial differences between the scenarios.

Figure 72. Distribution of Ecosite Phase Diversity Ratings – All Scenarios

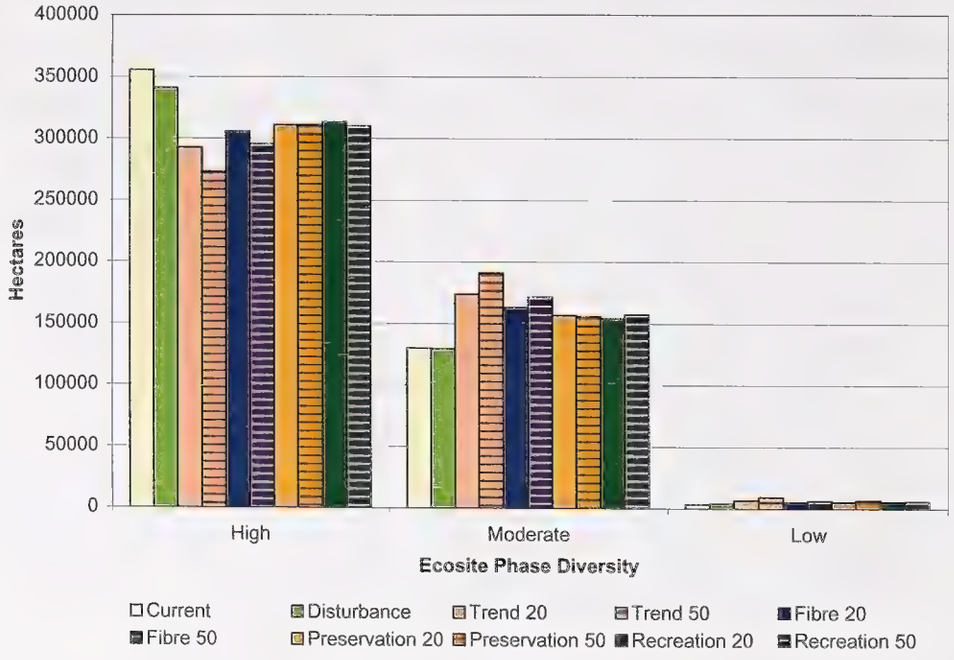
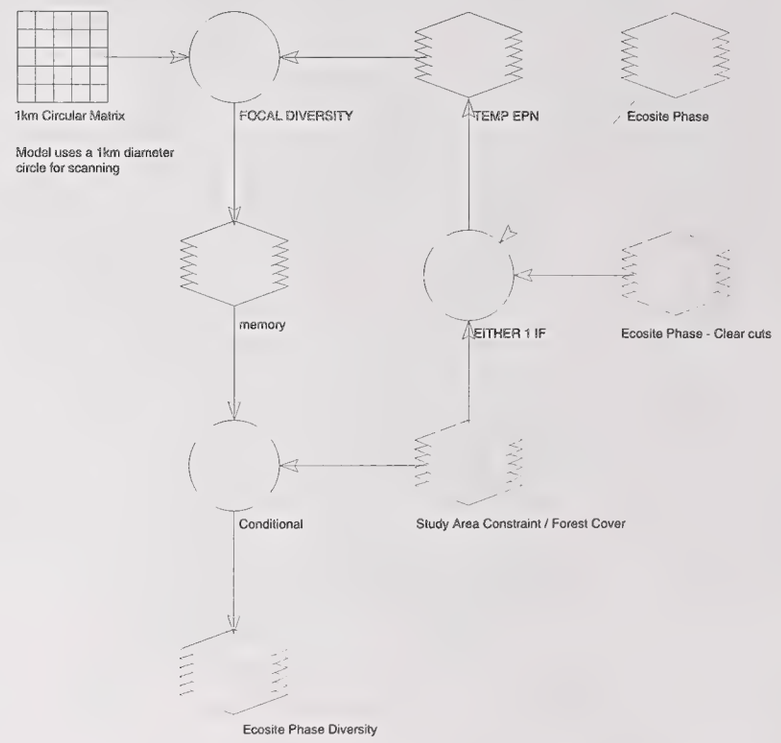
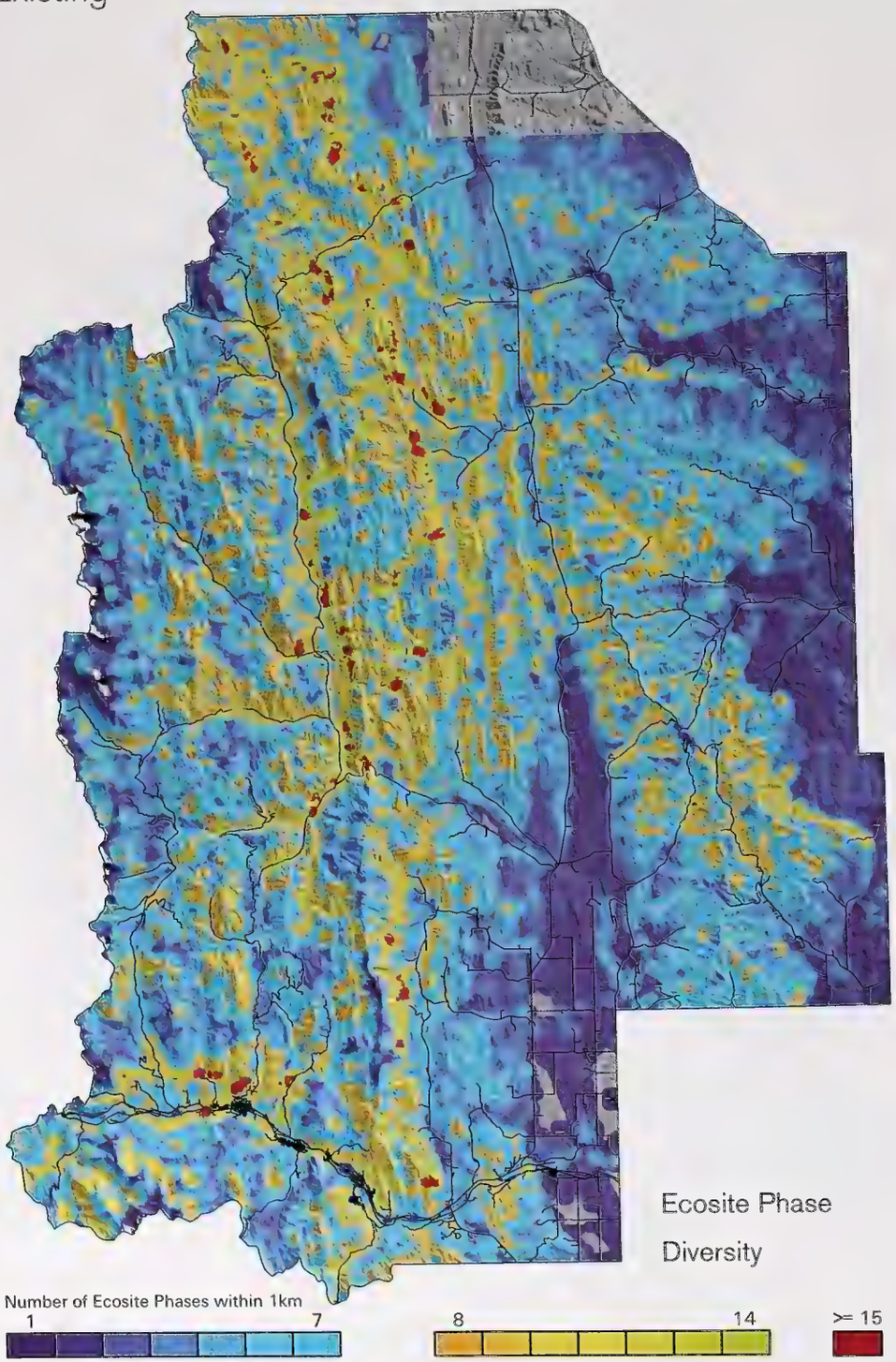


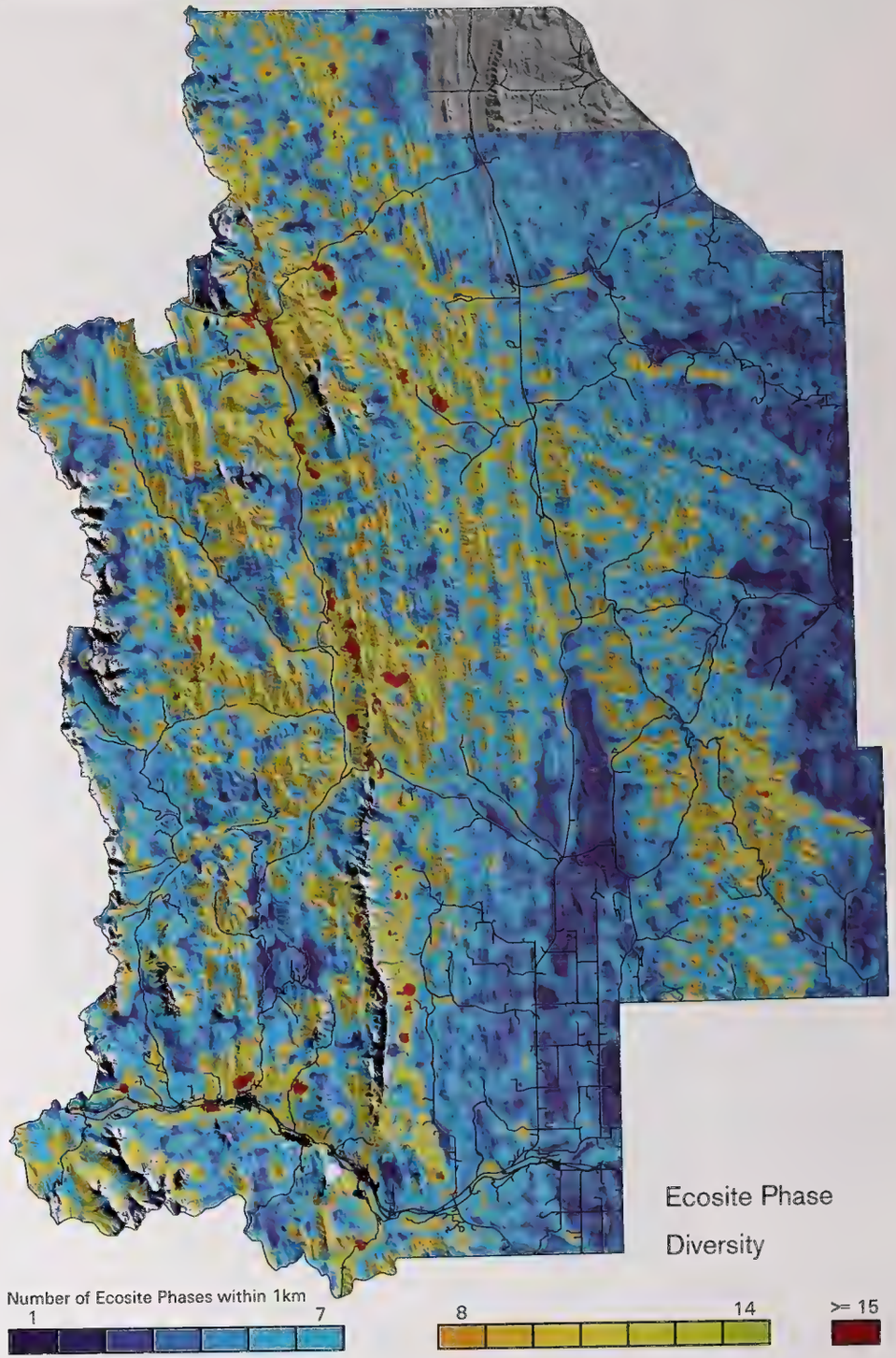
Figure 73. Ecosite Phase Diversity Graphical Model



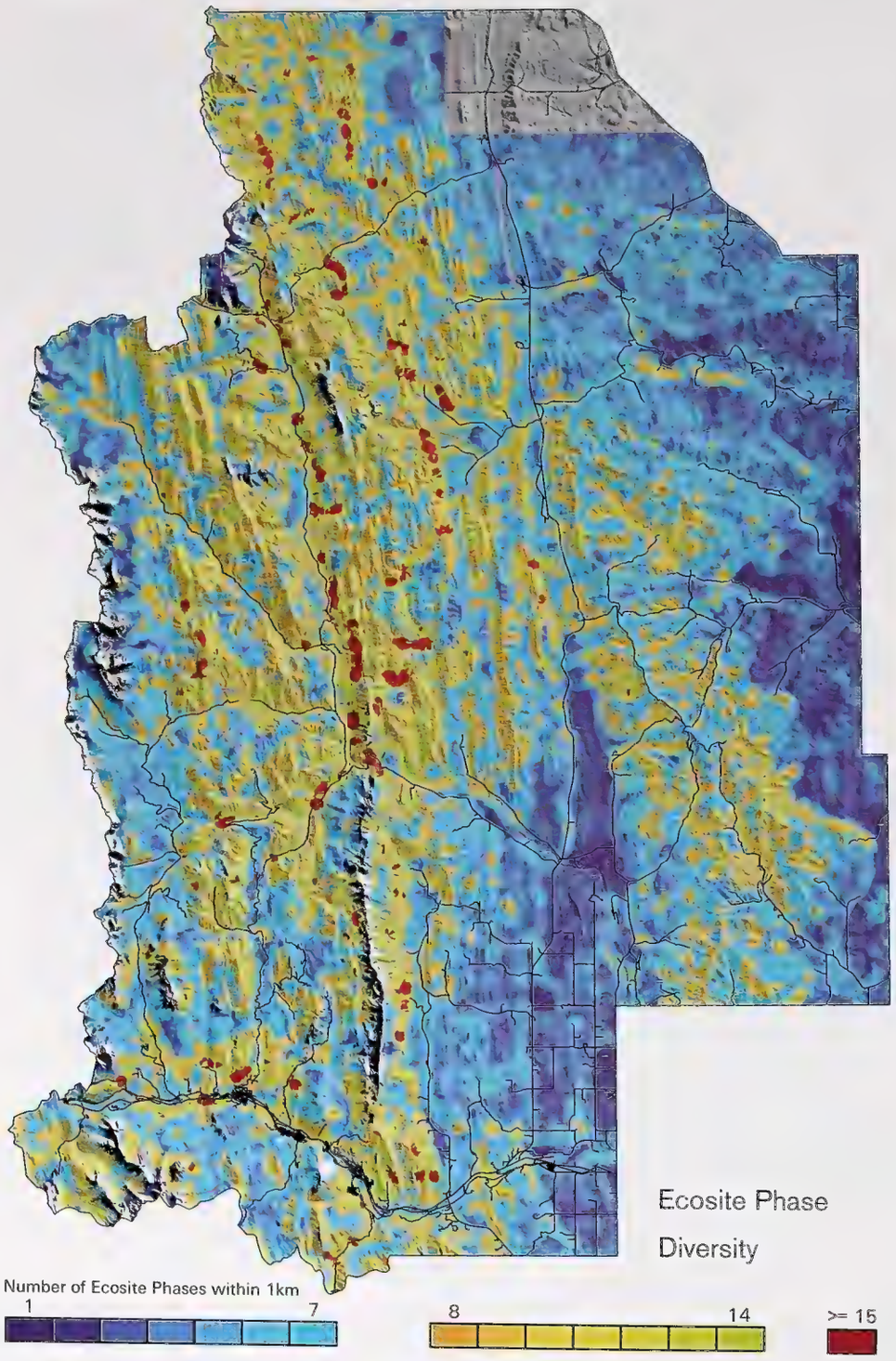
Existing



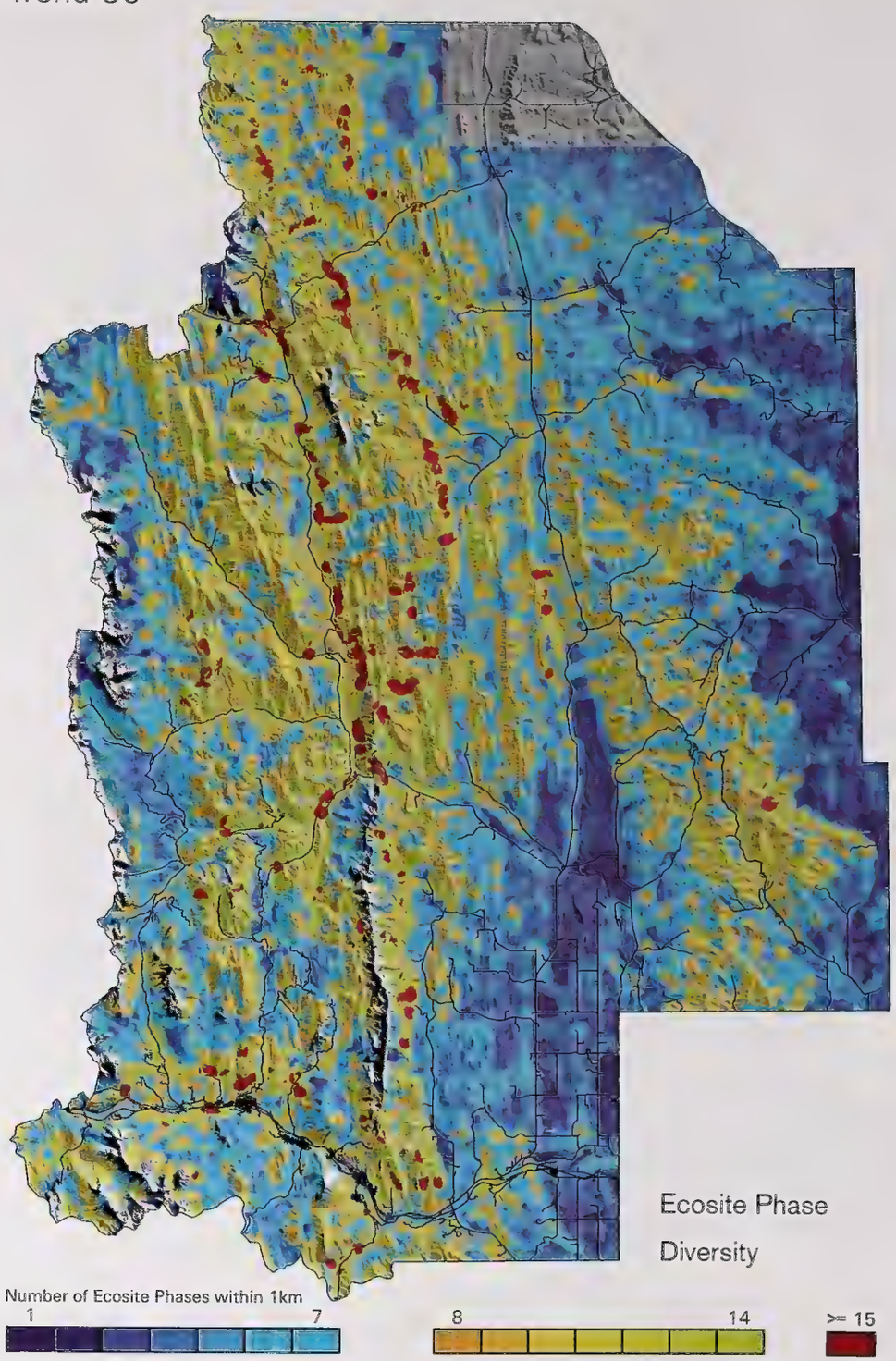
Disturbance



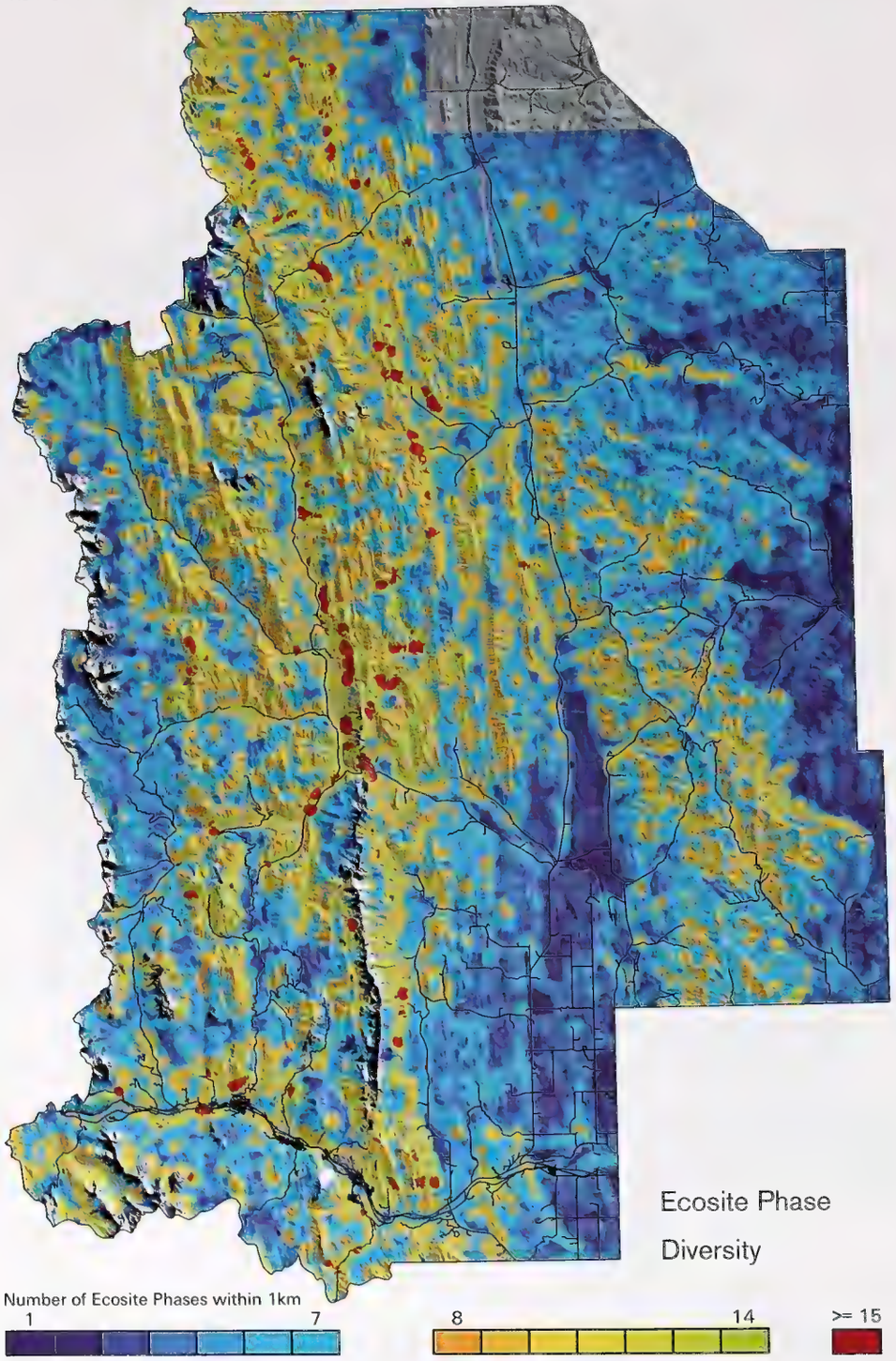
Trend 20



Trend 50



Fibre 20



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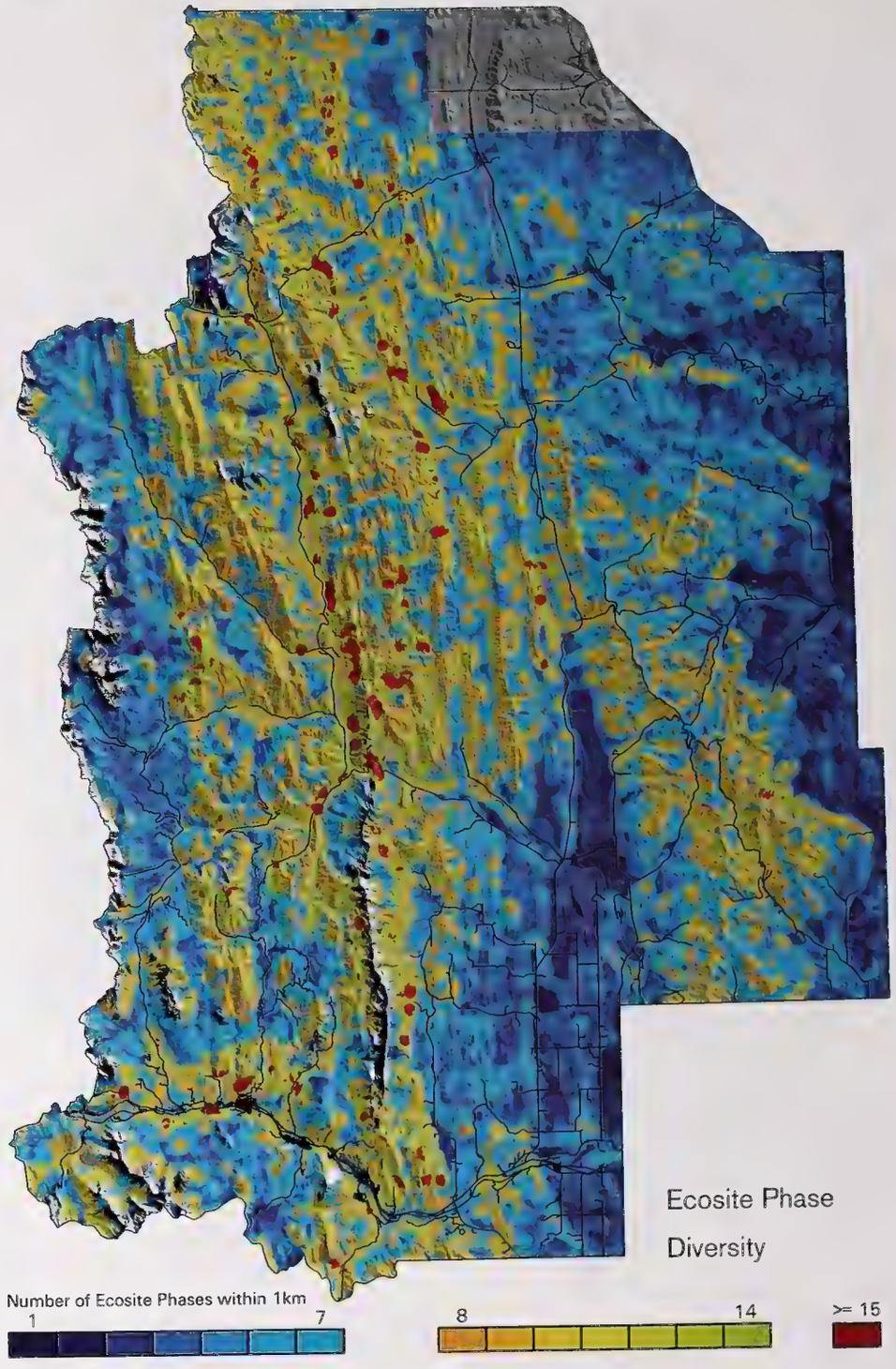
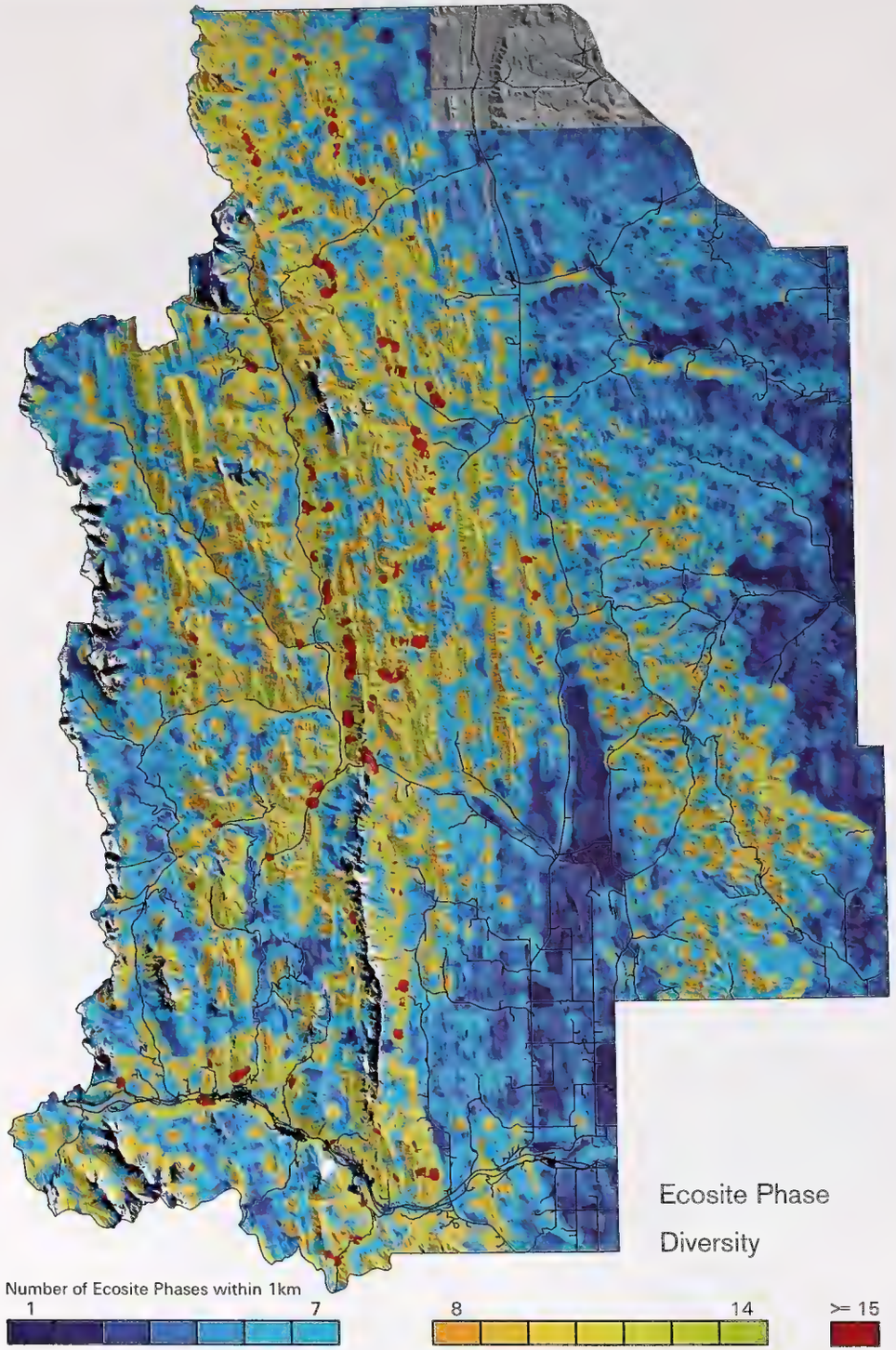


Preservation 20



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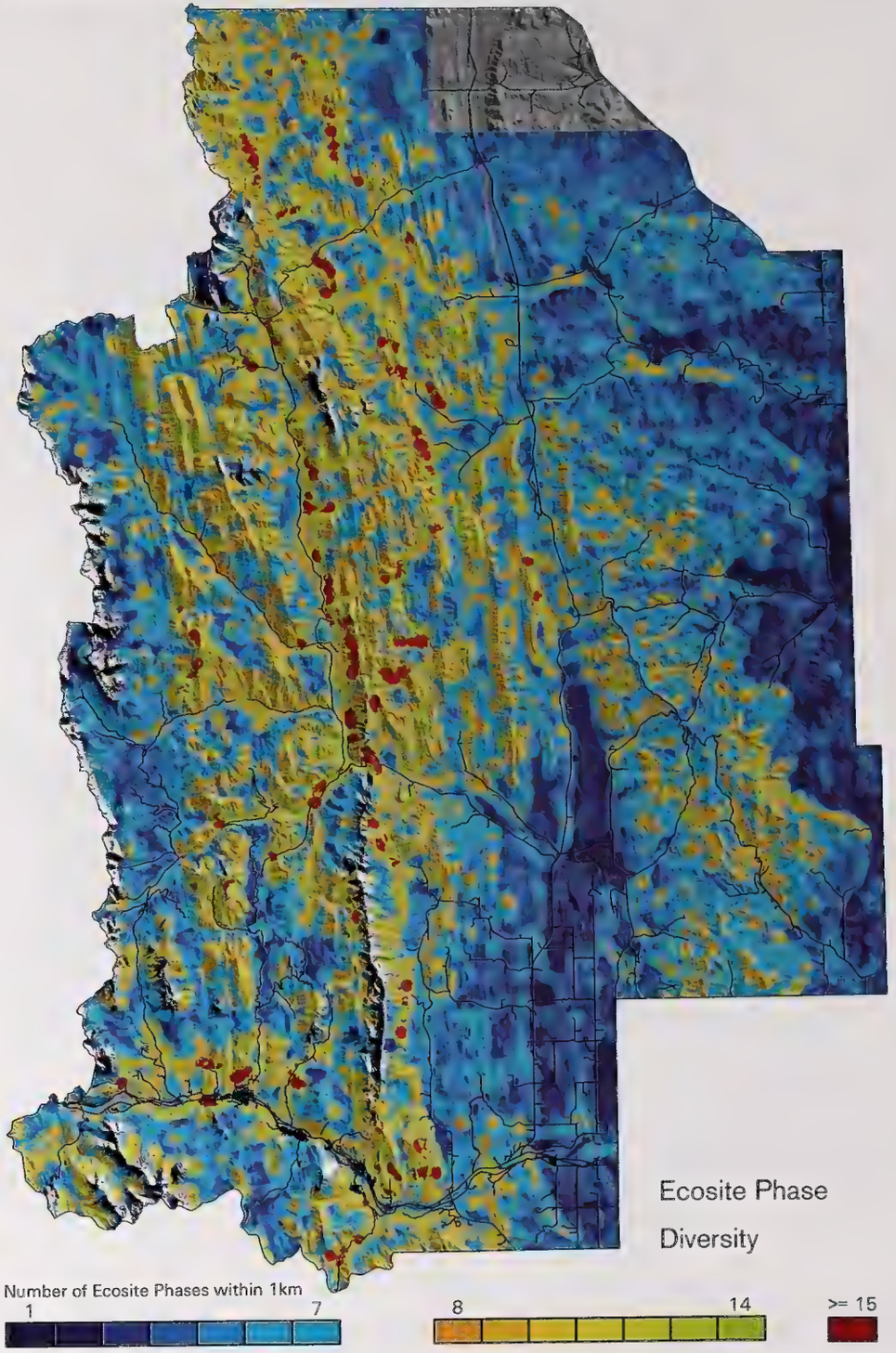
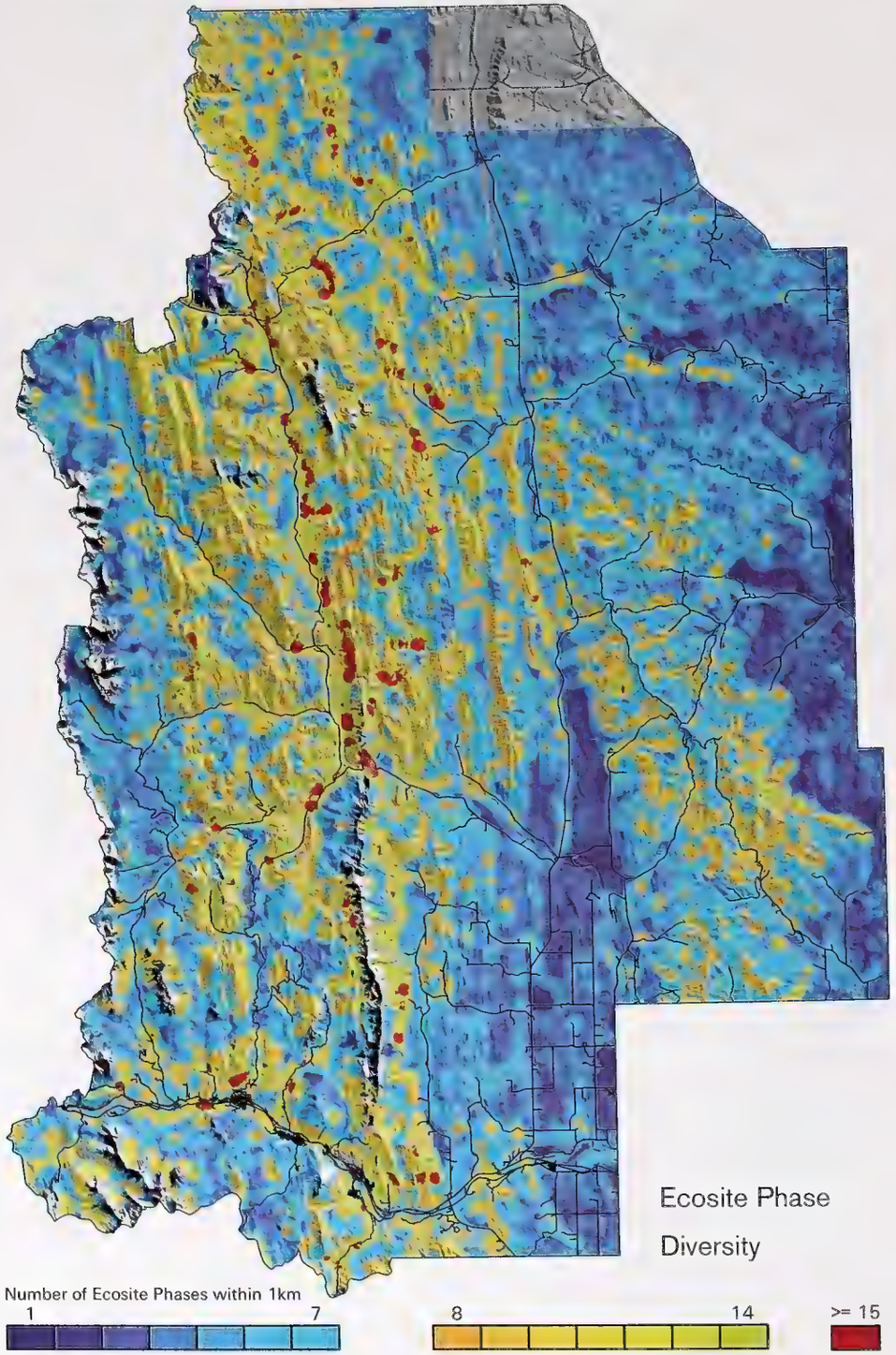
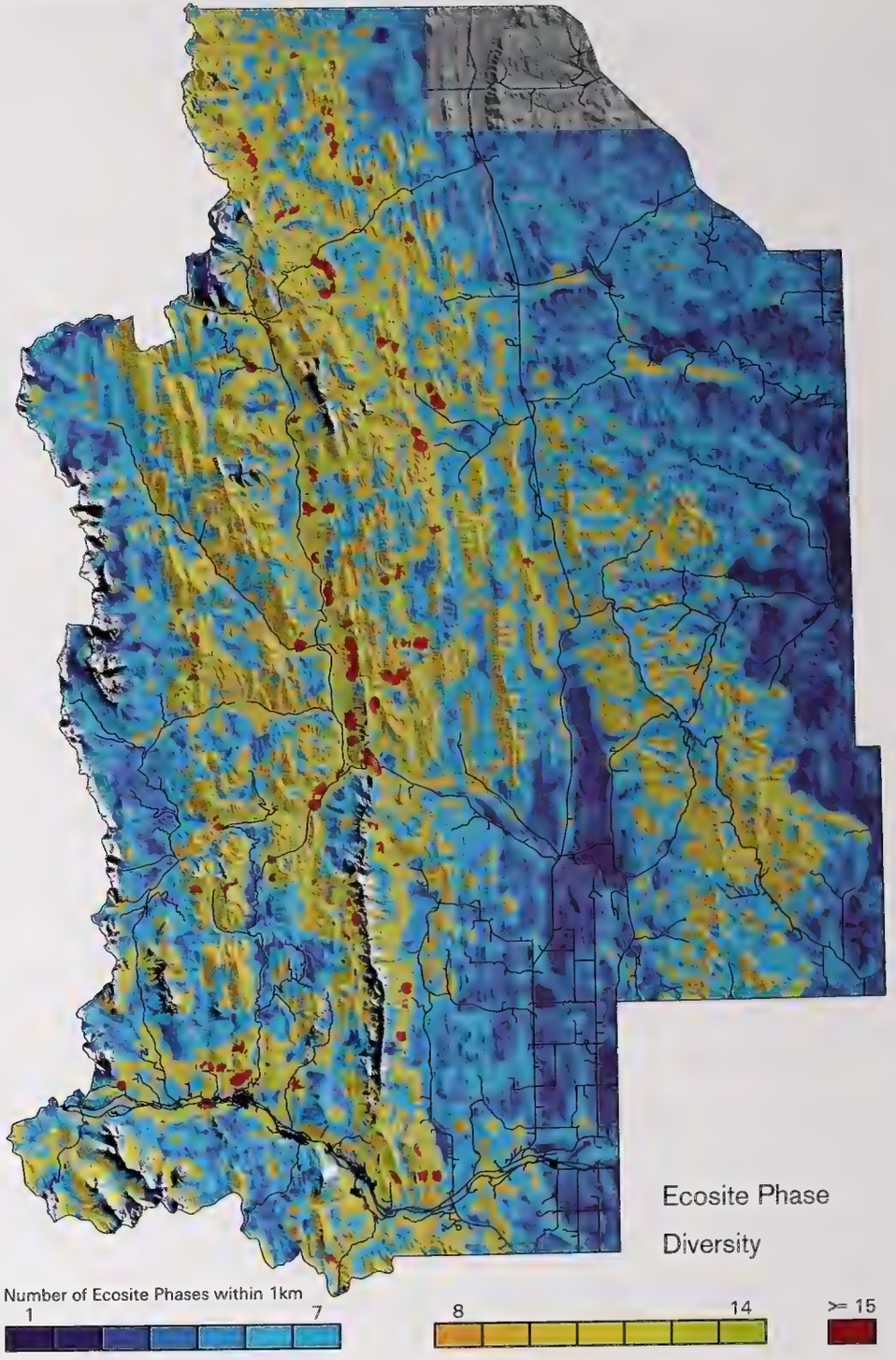


Recreation 20



Recreation 50



4.1.4. GENERALIZED LANDSCAPE PATTERN

Landscape ecology focuses on the spatial relationships between the structural and functional elements of the land. Research in the fields of landscape ecology, conservation biology, forestry and others indicates that spatial pattern plays an essential role in natural processes (Harris 1984, Franklin 1993, Soule 1987). The underlying hypothesis used in the evaluation of landscape ecological patterns is that there are certain essential or indispensable patterns that will conserve the majority of important ecological functions. While all or specific attributes of an ecosystem will not be protected by these measures, the most important will retain their integrity if the essential general patterns are maintained.

The patch – matrix – corridor model as described by Forman and Godron (1986) may be applied to any landscape at any scale. A landscape may be considered as a mosaic of the background matrix and patches connected by corridors. Forman (1995) suggests that the following are indispensable to providing an ecologically viable landscape:

- Large patches of natural vegetation which provide the benefits of species richness and habitat for interior species.
- Connectivity between large patches in the form of wide corridors or clusters of smaller patches of natural vegetation. At least some of these corridors or clusters of patches should be large enough to provide interior habitat.
- Vegetated corridors along major streams and rivers to provide for species movement, erosion control and protection of fish habitat. In addition, headwater seepage areas and first order streams should receive protection in the form of near contiguous vegetative cover.
- Stepping stones of small natural vegetation patches through altered landscapes to provide for such benefits as rare species habitats and species movement.

A map of elements of a generalized landscape pattern was created in order to assess the provision of some of these indispensable patterns. Vegetation patches were classed as either natural or anthropomorphic, making no distinction between forested or non–forested lands. Natural vegetation patches were bisected or "fractured" by "shear forces" such as large streams and rivers, human settlement, recent clearcuts, etc.

Regeneration greater than 20 years old returns to the natural vegetation class. The connectivity of the existing naturally vegetated landscape is measured by the amount of land in large connected patches.

The maps of generalized landscape pattern include the following classes:

Large Patches of Contiguous Natural Vegetation (the matrix) – Natural Vegetation Patches greater than 10,000 ha (created by dissecting natural vegetation with shear forces – see below)

Patches of Natural Vegetation – 1,000 – 10,000 ha

Isolated Natural Vegetation – Natural Vegetation Patches <1,000 ha

Shear Forces – fourth order and greater streams, lakes and ponds, barren rock, perennial forage, arable agriculture, human settlements, railroads, roadways (excluding trails, cutlines), major transmission lines, pipelines and recent clearcuts less than 20 years old. These forces fragment the landscape.

Natural Edges – The 25 m edge strip in a patch of natural vegetation

Vegetated Stream Corridors – natural vegetation within 25 m of a stream. Perennial forage or annual crops do not constitute natural vegetation and are therefore, not included.

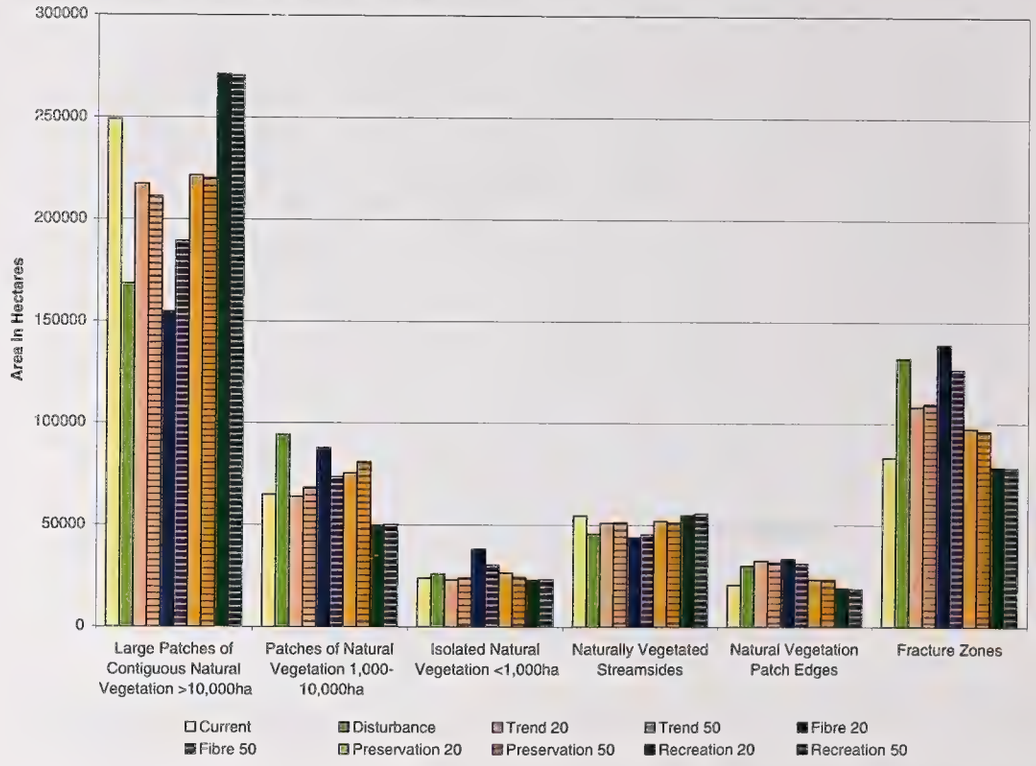
The resultant map, with its histogram, is a coarse summary of general landscape pattern conditions. The results indicate that the region is currently still largely composed of patches of natural vegetation over 1,000 ha. However, several portions of the region, particularly in the Foothills Fescue LMU, the Crowsnest Pass, the Headwater Valleys and in the lower reaches of the Livingstone Valley (refer LMU map page 11), as well as along Highway 22 and Willow Creek, are more highly fragmented and natural vegetation cover is more isolated.

Streamsides are well vegetated throughout most of the region. There are significant gaps in the natural vegetation connectivity of the riparian zones in the Crowsnest Pass and along the Oldman River and its tributaries through the Foothills Fescue LMU.

A large concentration of disturbed lands or those that act as "shear forces" or barriers in the landscape are found in the Crowsnest Pass. Highway #3 and the settlement areas of the Pass present a formidable barrier to many species. As development increases in the area and vegetation is converted or becomes more isolated, movement of many species both along the Crowsnest River Valley as well as north and south will become increasingly difficult.

The various future scenarios impact the landscape pattern to varying degrees. The Trend, while still leaving many areas in large patches, fragments the region in a highly dispersed manner. Important landscape connection zones to the north and south of Crowsnest Pass, such as Deadman's pass and the Flathead area, have been heavily impacted.

Figure 74. Generalized Landscape Pattern – All Scenarios



Ecological integrity is related to the configuration of the landscape and the relative distribution of important types of elements. Generally, it is not advisable to manage for increased patch edge. Many of the difficulties in wildlife management lie in protecting large patches with their associated interior species. Both the Trend and the Fibre Scenario significantly reduce the ecological quality of the landscape pattern. To a large degree, both the Preservation and the Recreation Scenarios protect indispensable patterns. The Fibre Scenario has a much higher impact, heavily fragmenting large areas to the south and north of Crowsnest Pass. Much of the area of very large patches and connected matrix is impacted under this scenario. Naturally vegetated streamsides are reduced and natural edges increase dramatically.

Existing

Generalized

Landscape Pattern

Contiguous Natural Vegetation > 10000ha

Isolated Natural Vegetation <1000ha

Naturally Vegetated Streamsides

Contiguous Natural Vegetation 1000 -10000ha

Fracture Zones

Natural Patch Edges

Disturbance

Generalized

Landscape Pattern

Contiguous Natural Vegetation > 10000ha

Isolated Natural Vegetation <1000ha

Naturally Vegetated Streamsides

Contiguous Natural Vegetation 1000 -10000ha

Fracture Zones

Natural Patch Edges

Trend 20

Trend 50

Fibre 20

Generalized

Landscape Pattern

Contiguous Natural Vegetation > 10000ha

Isolated Natural Vegetation <1000ha

Naturally Vegetated Streamsides

Contiguous Natural Vegetation 1000 -10000ha

Fracture Zones

Natural Patch Edges

Fibre 50

Generalized

Landscape Pattern

Contiguous Natural Vegetation > 10000ha

Isolated Natural Vegetation <1000ha

Naturally Vegetated Streamsides

Contiguous Natural Vegetation 1000 -10000ha

Fracture Zones

Natural Patch Edges

Preservation 20

Preservation 50

Recreation 20

Recreation 50

4.1.5. SPECIAL, UNIQUE & RARE ELEMENTS

The protection of special, unique or rare elements in the landscape is an important management consideration for the area. The following elements have been identified as warranting special protection or management. The list is not exclusive and other elements may be added.

Ecosite Phases of less than 100 ha
Areas of National Environmental Significance
Areas of Provincial Environmental Significance
Areas with the Highest Avian Diversity
Areas of Highest Ecosite Phase Diversity
Areas of Highest Visual Value
Old Growth Forest (over 200 years)
Areas of Highest Quality Grizzly Habitat
Elk Calving Grounds
Rare Plant Locations (with 200 m buffer)
Archaeological Sites (with 200 m buffer)

The degree that the various alternatives impact these special elements has been calculated. All special elements are assigned a value of 1 and are summed in a single map of all potential elements. Several elements could potentially be on the same site, i.e. an archaeological site could have high visual value and also be an elk calving ground. An individual pixel in the summation map acquires the value of the total number of special elements on the site. The model currently places equal weight on all elements, but can easily be modified to give additional importance to individual characteristics.

The map of impacted special elements indicates the total number of special elements that have been impacted by either cutblocks or burn areas, depending on the scenario. The Summary Table 5 (page 129) indicates the area and type of each special element that has been impacted by each scenario. The bar chart (Figure 75 below), on the other hand, indicates the total area impacted without regard for the cumulative impact.

Figure 75. Special, Unique & Rare – All Scenarios

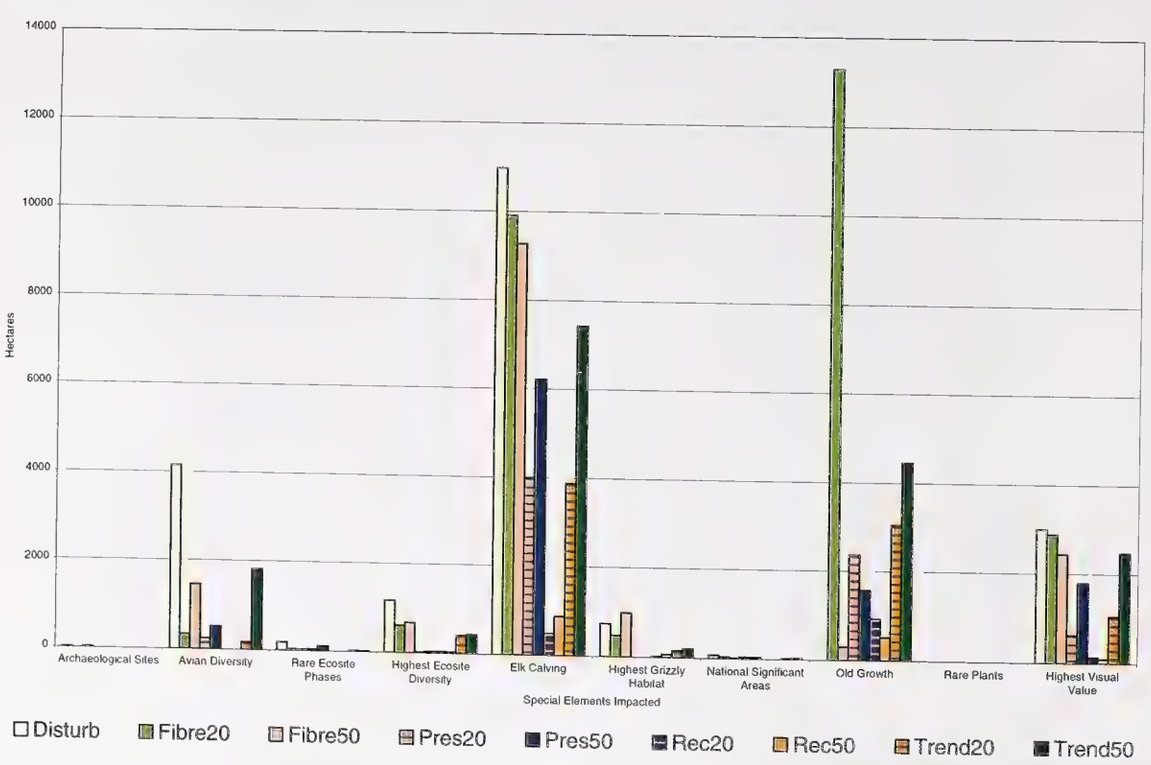
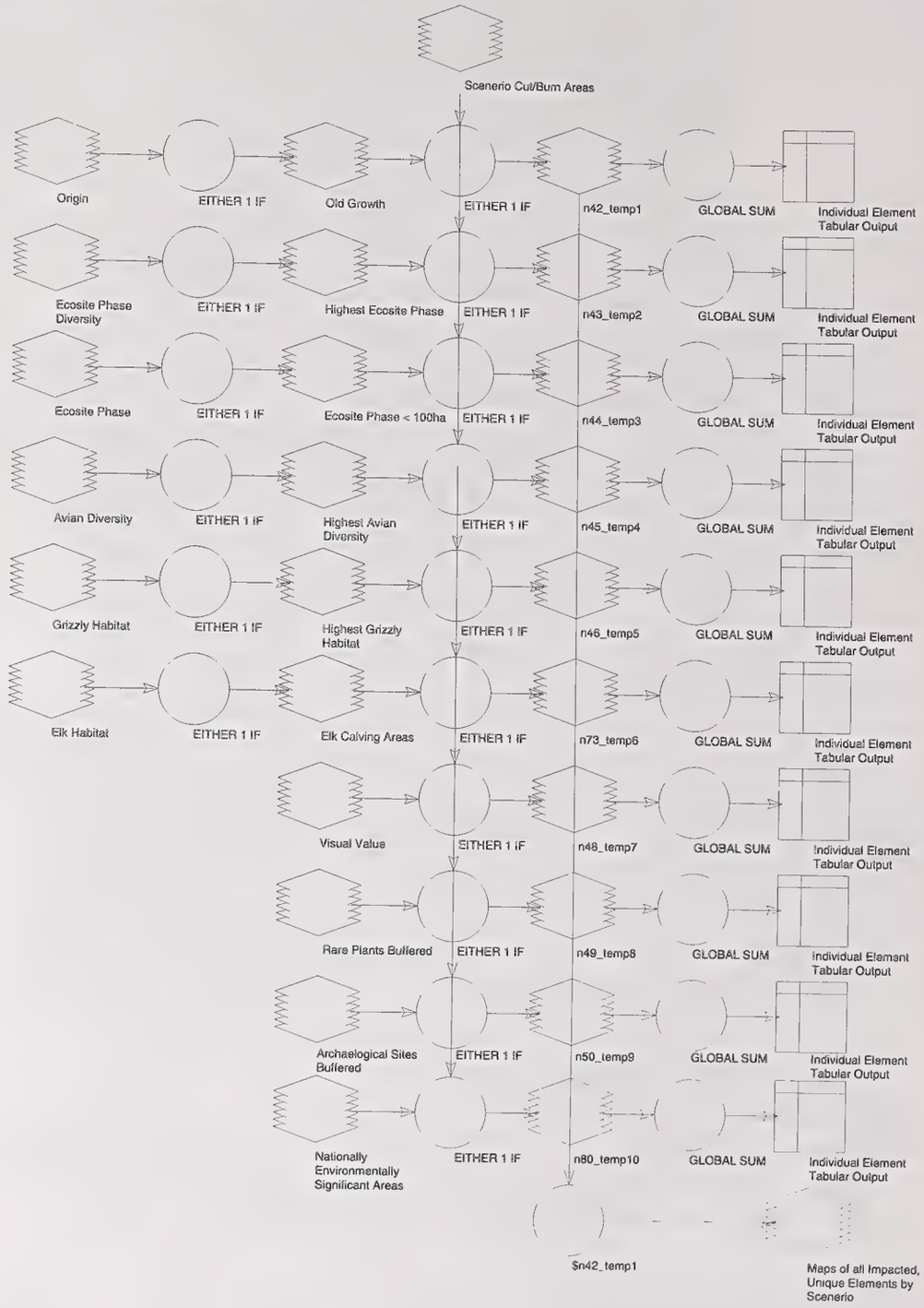


Figure 76. Special, Unique & Rare Graphical Model



Ecosite Phase < 100 ha

Highest Ecosite Phase Diversity

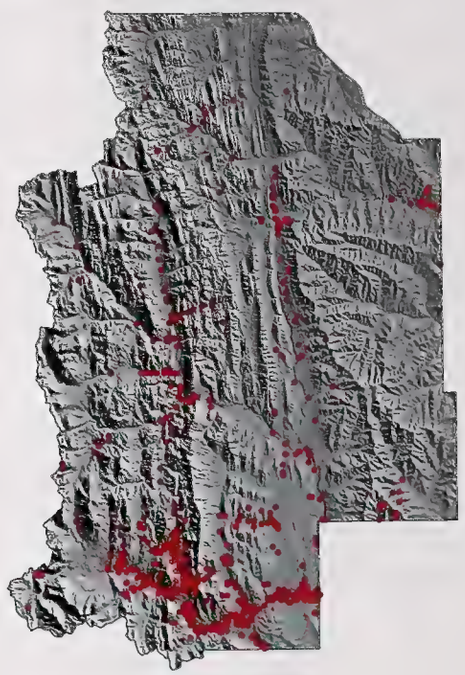
Highest Avian Diversity

Old Growth Forest >= 200 years

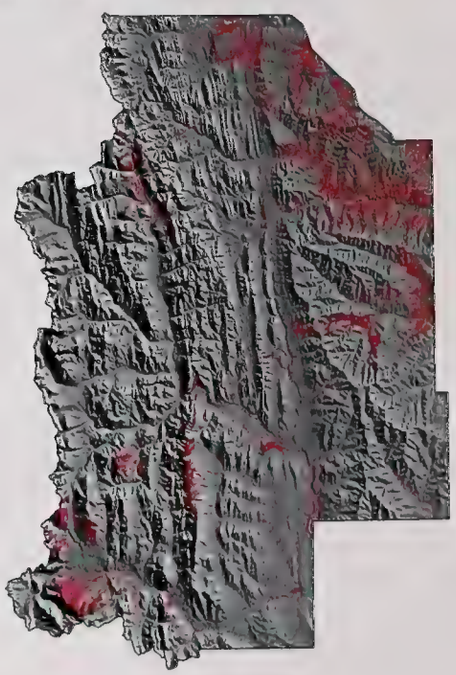
Elk Calving Grounds

Rare Plants

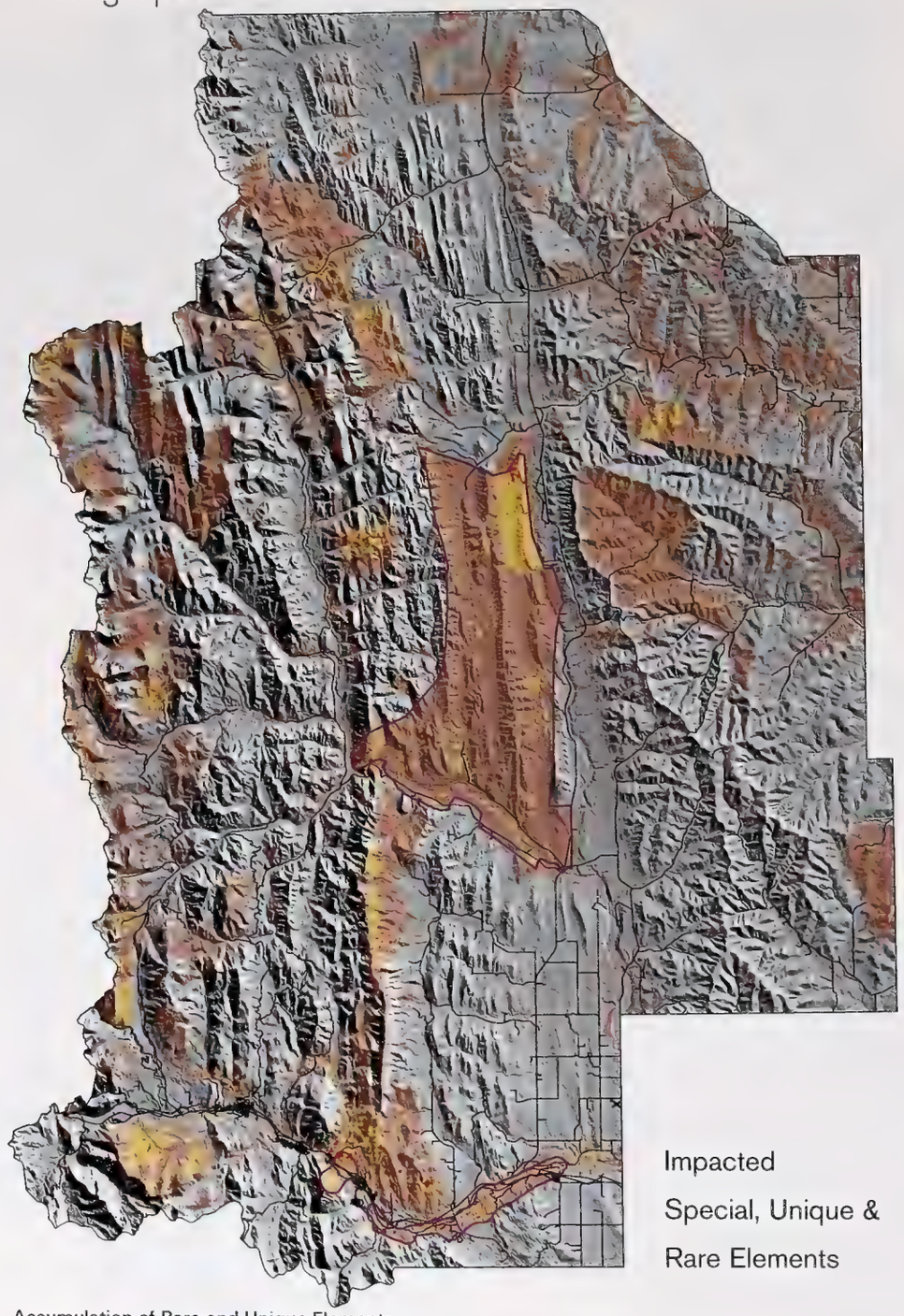
Archaeological Sites



Highest Visual Value



Existing Special Elements

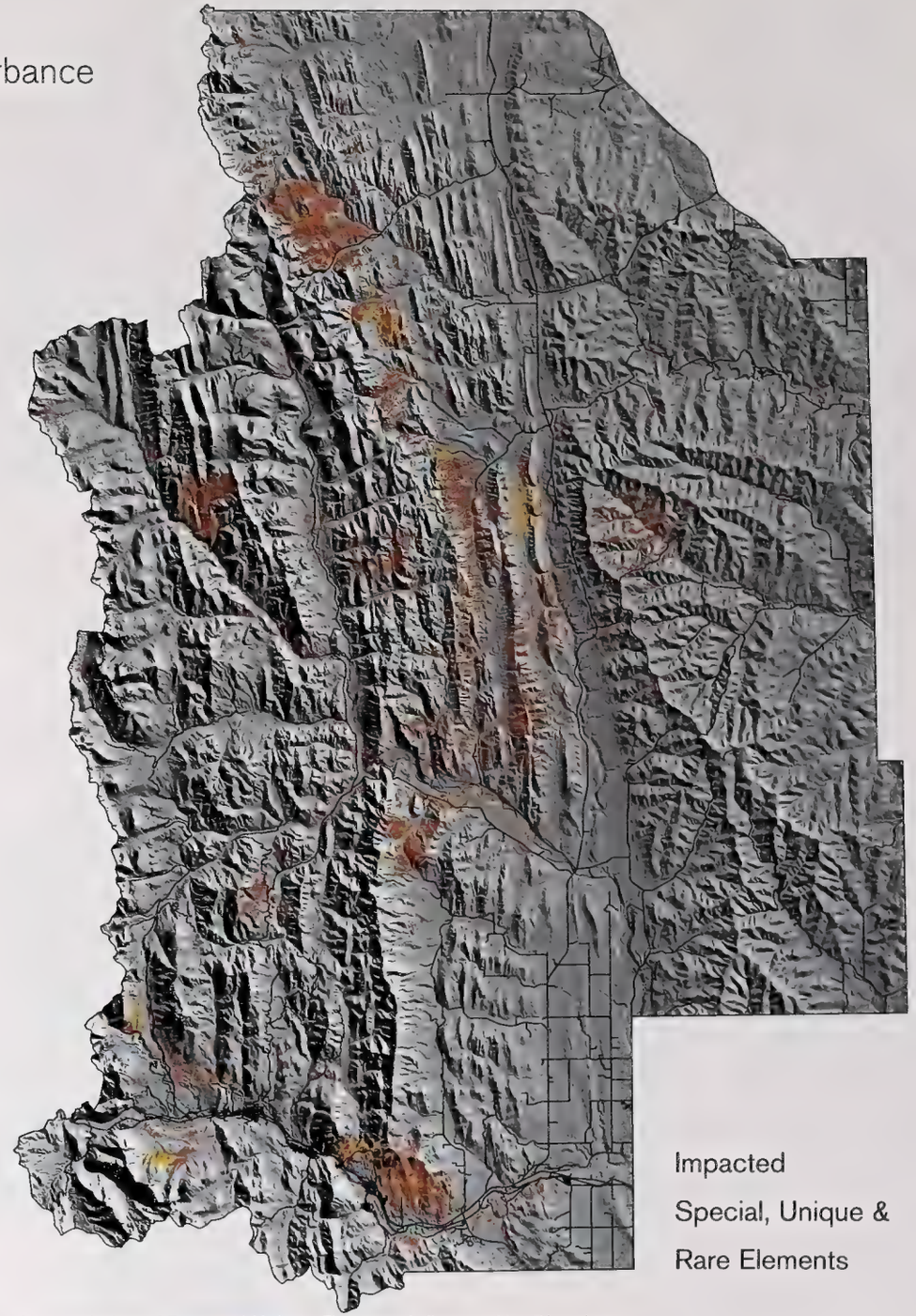


Impacted
Special, Unique &
Rare Elements

Accumulation of Rare and Unique Elements
1 Element 2 Elements 3 or more Elements

Area of National
Environmental Significance

Disturbance



Impacted
Special, Unique &
Rare Elements

Accumulation of Rare and Unique Elements Influenced by Disturbance
1 Element 2 Elements 3 or more Elements

Trend 20

Impacted
Special, Unique &
Rare Elements

Accumulation of Rare and Unique Elements Influenced by Disturbance
1 Element 2 Elements 3 or more Elements

Trend 50

Impacted
Special, Unique &
Rare Elements

Accumulation of Rare and Unique Elements Influenced by Disturbance
1 Element 2 Elements 3 or more Elements

Fibre 20

Impacted
Special, Unique &
Rare Elements

Accumulation of Rare and Unique Elements Influenced by Disturbance
1 Element 2 Elements 3 or more Elements

Fibre 50

Impacted
Special, Unique &
Rare Elements

Accumulation of Rare and Unique Elements Influenced by Disturbance
1 Element 2 Elements 3 or more Elements

Preservation 20

Impacted
Special, Unique &
Rare Elements

Accumulation of Rare and Unique Elements Influenced by Disturbance
1 Element 2 Elements 3 or more Elements

Preservation 50

Impacted
Special, Unique &
Rare Elements

Accumulation of Rare and Unique Elements Influenced by Disturbance
1 Element 2 Elements 3 or more Elements

Recreation 20

Impacted
Special, Unique &
Rare Elements

Accumulation of Rare and Unique Elements Influenced by Disturbance
1 Element 2 Elements 3 or more Elements

Recreation 50

Impacted
Special, Unique &
Rare Elements

Accumulation of Rare and Unique Elements Influenced by Disturbance
1 Element 2 Elements 3 or more Elements

Summary of Impacts

The impact of the scenarios on the special, unique and rare elements varies by scenario. While Table 5 indicates the area in hectares of projected disturbance patches (either cutblocks or burn areas) that fall on those areas listed as special elements, the interpretation of the data cannot be undertaken simplistically. Individual elements are not equal to one another and, in a planning exercise, it is expected that the elements would be weighted. The potential for weighting importance values is accommodated in the model. In addition, the set of elements that has been identified is incomplete and subject to change in a real planning situation. Many elements are site specific and immovable while others, such as old growth, may shift around in the changing forest mosaic. The impacts are based upon existing conditions.

The usefulness of the assessment is to quickly identify to land managers the areas of potential impact. This may lead to modifications in management that mitigate the potential impact or, in some cases, lead to avoidance of the area.

The Disturbance Scenario has the highest impact of any scenario in every category, simply because of its large extent. The Trend has significant impact on old growth taking out almost half of the existing old growth in the area over the next 50 years. The Fibre Scenario is even more severe with almost all of the current old growth sequenced for harvesting. Rare plants are impacted in the Fibre Scenario more than any other. In fact, 20% of the mapped sites are impacted.

The Preservation Scenario disturbs a large percentage of the known elk calving areas through burning. This will have to be considered in the design and timing of the prescribed burn. The Recreation Scenario has the lowest impact on every category.

Areas of Environmental Significance (National, Provincial, Regional, Local)

Table 5: Summary of Impacts

Scenario	Archaeological Sites		Avian Diversity		Rare Ecosite Phases		Highest Ecosite Diversity		Elk Calving Areas		Highest Grizzly Habitat		National Significant Areas		Old Growth		Rare Plants		Highest Visual Value	
	Area Impacted	% Impacted	Area Impacted	% Impacted	Area Impacted	% Impacted	Area Impacted	% Impacted	Area Impacted	% Impacted	Area Impacted	% Impacted	Area Impacted	% Impacted	Area Impacted	% Impacted	Area Impacted	% Impacted	Area Impacted	% Impacted
Current	72.2	0.0%	9649.2	0.0%	940.4	0.0%	3480.8	0.0%	48471.8	0.0%	1992.0	0.0%	310.0	0.0%	15100.3	0.0%	12.7	0.0%	42627.1	0.0%
Disturb	11.1	15.4%	4142.1	42.9%	173.1	18.4%	1162.3	33.4%	10968.6	22.6%	733.0	36.8%	70.5	22.7%	0.0	0.0%	1.4	11.0%	2991.5	7.0%
Fibre20	3.2	4.5%	330.1	3.4%	23.9	2.5%	603.4	17.3%	9905.3	20.4%	481.0	24.1%	39.5	12.7%	13279.8	87.9%	1.5	11.9%	2878.9	6.8%
Fibre50	7.2	10.0%	1457.1	15.1%	28.7	3.1%	677.3	19.5%	9267.1	19.1%	975.0	48.9%	15.0	4.8%	288.8	1.9%	1.2	9.6%	2439.3	5.7%
Pres20	2.2	3.1%	249.5	2.6%	31.5	3.3%	10.0	0.3%	3984.1	8.2%	0.0	0.0%	32.9	10.6%	2361.8	15.6%	0.2	1.5%	628.5	1.5%
Pres50	4.8	6.6%	512.9	5.3%	100.4	10.7%	37.6	1.1%	6216.9	12.8%	0.0	0.0%	32.4	10.5%	1570.8	10.4%	0.5	4.2%	1800.4	4.2%
Rec20	0.4	0.5%	0.0	0.0%	3.7	0.4%	31.3	0.9%	494.1	1.0%	13.0	0.7%	0.1	0.0%	931.6	6.2%	0.2	1.5%	132.4	0.3%
Rec50	0.2	0.2%	0.0	0.0%	4.6	0.5%	26.9	0.8%	876.8	1.8%	65.0	3.3%	0.1	0.0%	512.6	3.4%	0.0	0.3%	90.3	0.2%
Trend20	2.8	3.8%	168.5	1.7%	7.6	0.8%	396.0	11.4%	3867.3	8.0%	147.0	7.4%	17.1	5.5%	3044.0	20.2%	0.4	3.2%	1054.3	2.5%
Trend50	2.8	3.9%	1816.6	18.8%	15.3	1.6%	432.5	12.4%	7425.5	15.3%	193.0	9.7%	21.6	7.0%	4454.4	29.5%	0.4	3.5%	2468.1	5.8%

areas in hectares

Current = the existing extent of the elements
Area Impacted = the areal extent impacted/influenced by the scenario
% Impacted = the percentage of the existing area of the element that is impacted

Fire Related Models

4.1.6. FIRE RELATED MODELS

Landscape patterns and processes are closely related to disturbance regimes. In the Southern Rockies study area, fire, insects, disease, wind, avalanches and, to a lesser extent, landslides are the major natural disturbances that have occurred for thousands of years and which have given rise to the current landscape structure. Until recent years when control has become effective, the overwhelming mechanism for disturbance and subsequent forest origin in the area was fire (Johnson, E.A., and G.I. Fryer 1987, Day 1972).

Fire has also been the dominant disturbance force in the grassland and shrub communities of the foothill parklands and prairies. Knowledge of the historical disturbance regime is important in order to evaluate the sustainability of current and potential landscape patterns. The full impact of various management interventions is unknown or may not become apparent for many years. Therefore, historical patterns of heterogeneity should be followed or, at the very least, understood and acknowledged in order to reduce the risk of losing biodiversity and disrupting ecological processes (Turner et. al.1994). The Disturbance and Pattern Analysis report examined this area of investigation and readers are referred to that volume for more detail.

The regional landscape is one that is characterized by extremely large fires or sets of fires that occur over a relatively short period of time. The map of fires that occurred between 1890 and 1930 clearly and dramatically demonstrates this. The landscape has been shaped by large conflagrations which are likely to reoccur unless serious efforts are made to modify fuels and to "cool down" the forest. If the forest can be compartmentalized so fire control agencies can utilize landscape anchor points such as rock barriers, streams, roadways and low flammability vegetation types, efforts to manage fire within the landscape will be more effective. Many areas, particularly the subalpine Middle Ridges landscape and to some extent the Headwater Valleys, are in large contiguous expanses of highly flammable fuels. In order to reduce the potential for large fire events, these fuels need to be modified in strategic areas. The potential for these broadscale fire events may be reduced by; stand conversion, selection harvest, anchor points, prescribed burning, thinning, and timing of harvest.

In order to pinpoint those areas where fuel reduction efforts would best serve fire management requirements, two models have been produced; Fire Behaviour Potential and Head Fire Intensity. In addition to spatially locating areas of high fuel flammability and areas where fire intensity is likely to be problematic, the models have been used to spatially quantify the impacts of the various scenarios.

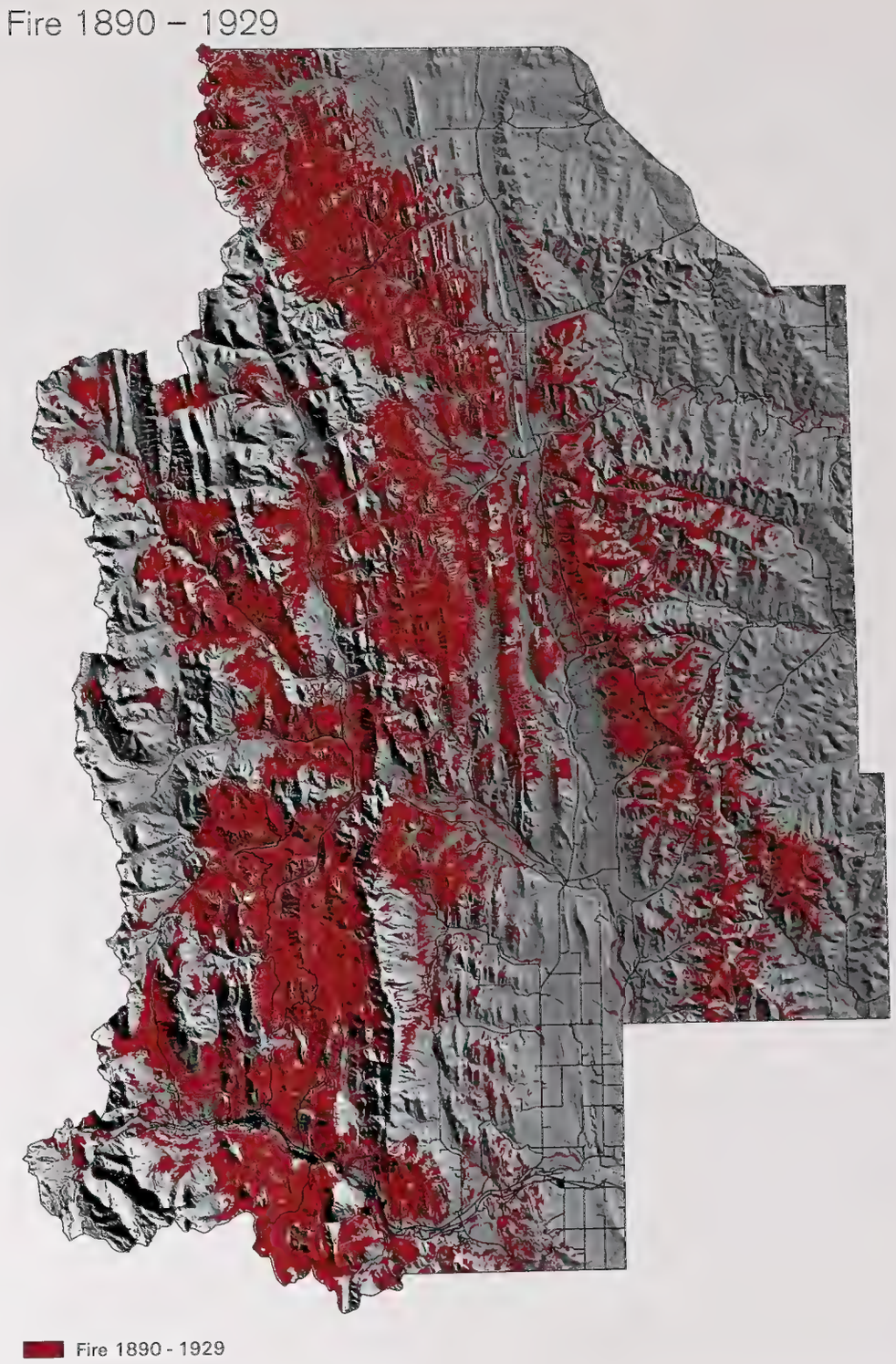
4.1.6.1. FIRE BEHAVIOUR POTENTIAL (FBP) FUEL TYPES

The Fire Behaviour Potential (FBP) classification is a national system applied to the Alberta Vegetation Inventory (AVI) by the Forest Protection Division of Alberta Environment. The AVI was classified into 16 fire behaviour types. As all scenarios are described in terms of ecosite phase, the model was modified for use with ecosite phase. Figure 78 indicates the graphical diagram of the computer model.

The primary inputs to the Fire Behaviour Potential model are ecosite phase, tree height, age and canopy closure. The model calculates FBP by natural subregion and then aggregates for the region. The Fire Behaviour Potential Types mapped in the study include:

C1 – Spruce/Lichen Woodland
C2 – Spruce
C3 – Mature Lodgepole Pine
C4 – Immature Lodgepole Pine
C7 – Douglas Fir
D1 – Leafless Aspen
O1 – Matted/Standing Grass
M1/M2 – Mixedwood
NF – Non Fuel

Figure 77 indicates the changes to Fire Behaviour types under the various scenarios. There are considerable differences between the scenarios, particularly in the pine types.



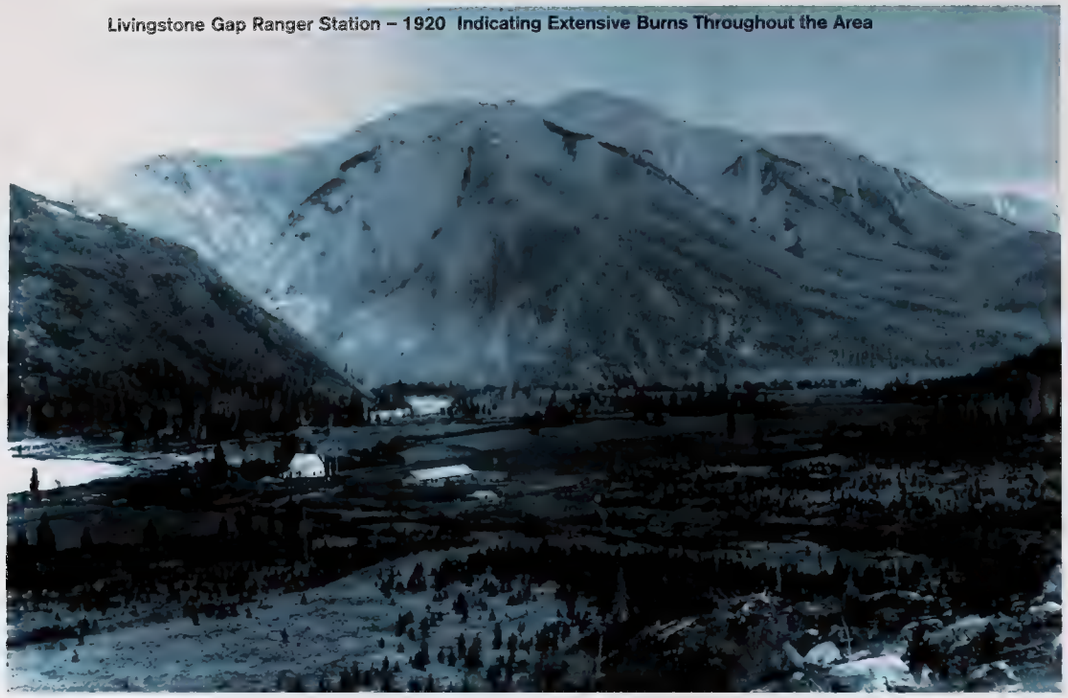
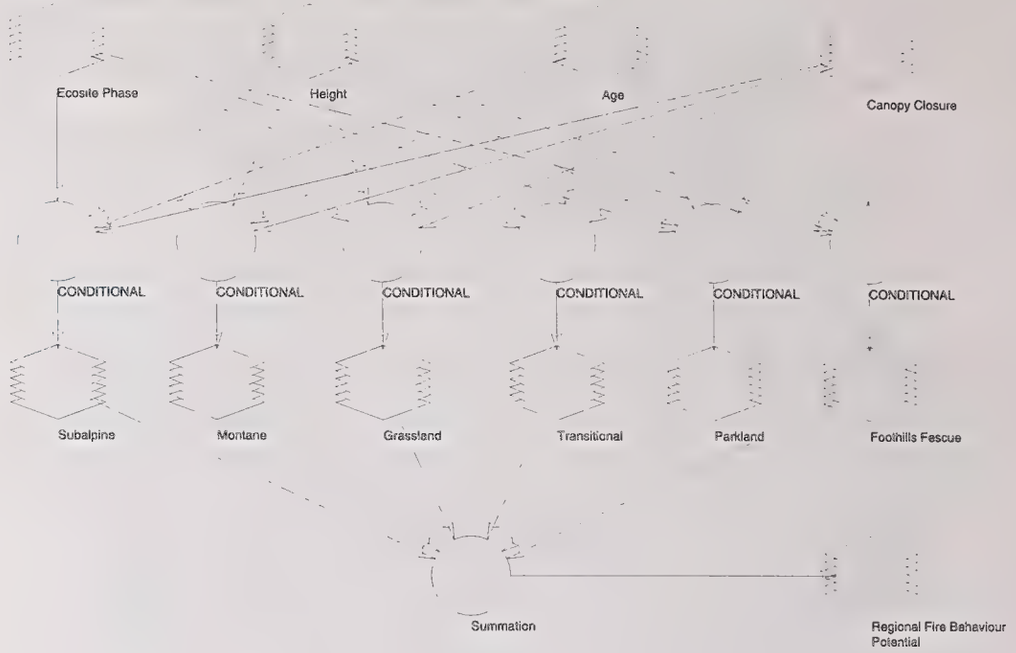
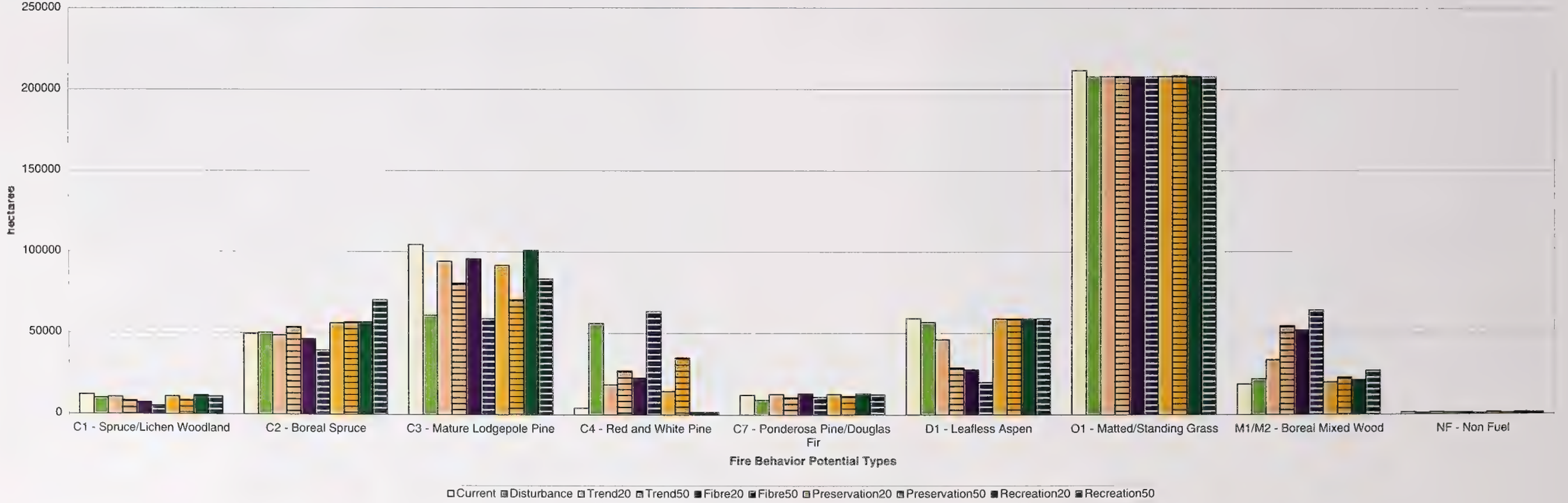


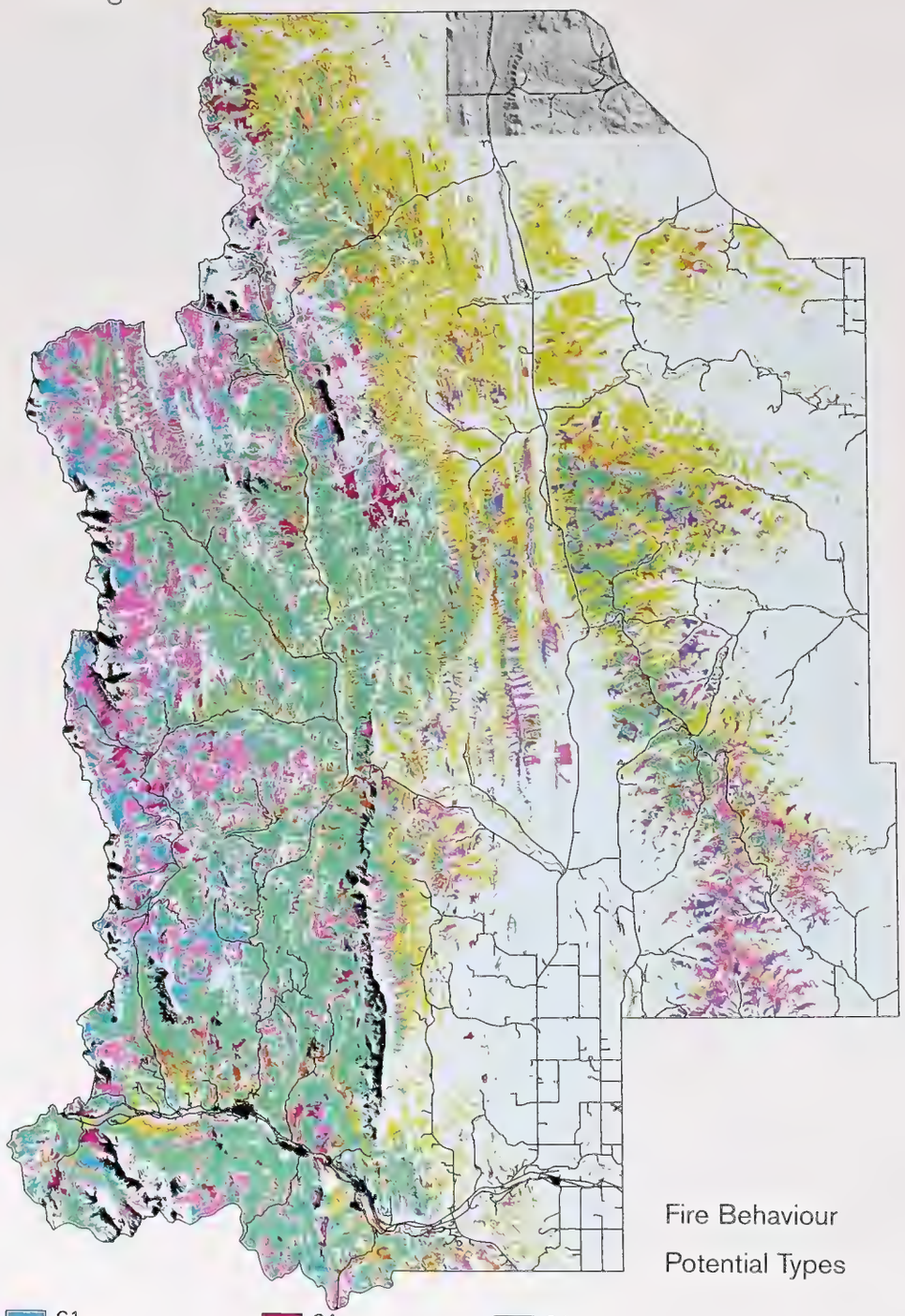
Figure 77. Fire Behaviour Potential Types By Scenario

Figure 78. Fire Behaviour Potential (FBP) Fuel Types Graphical Model

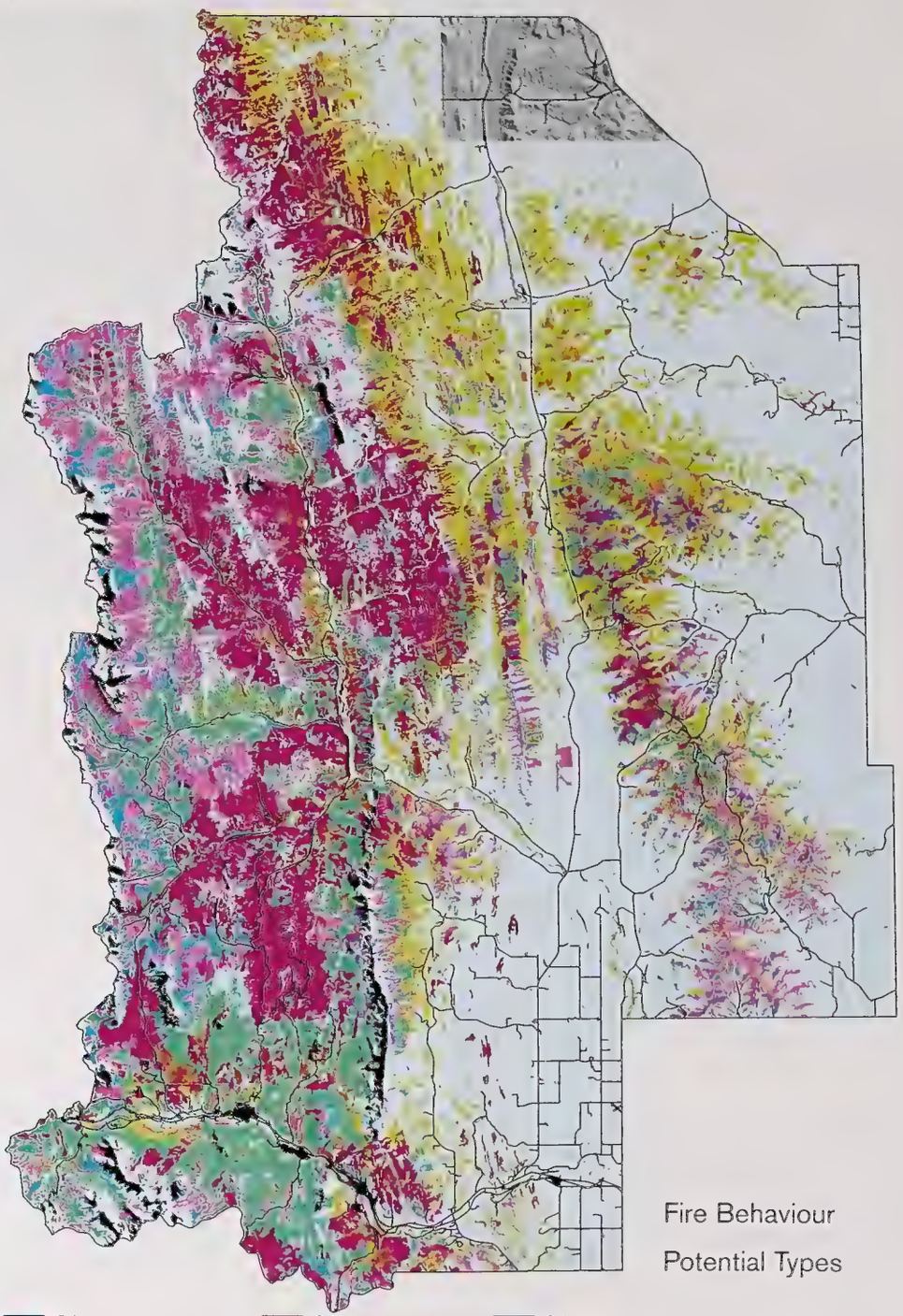




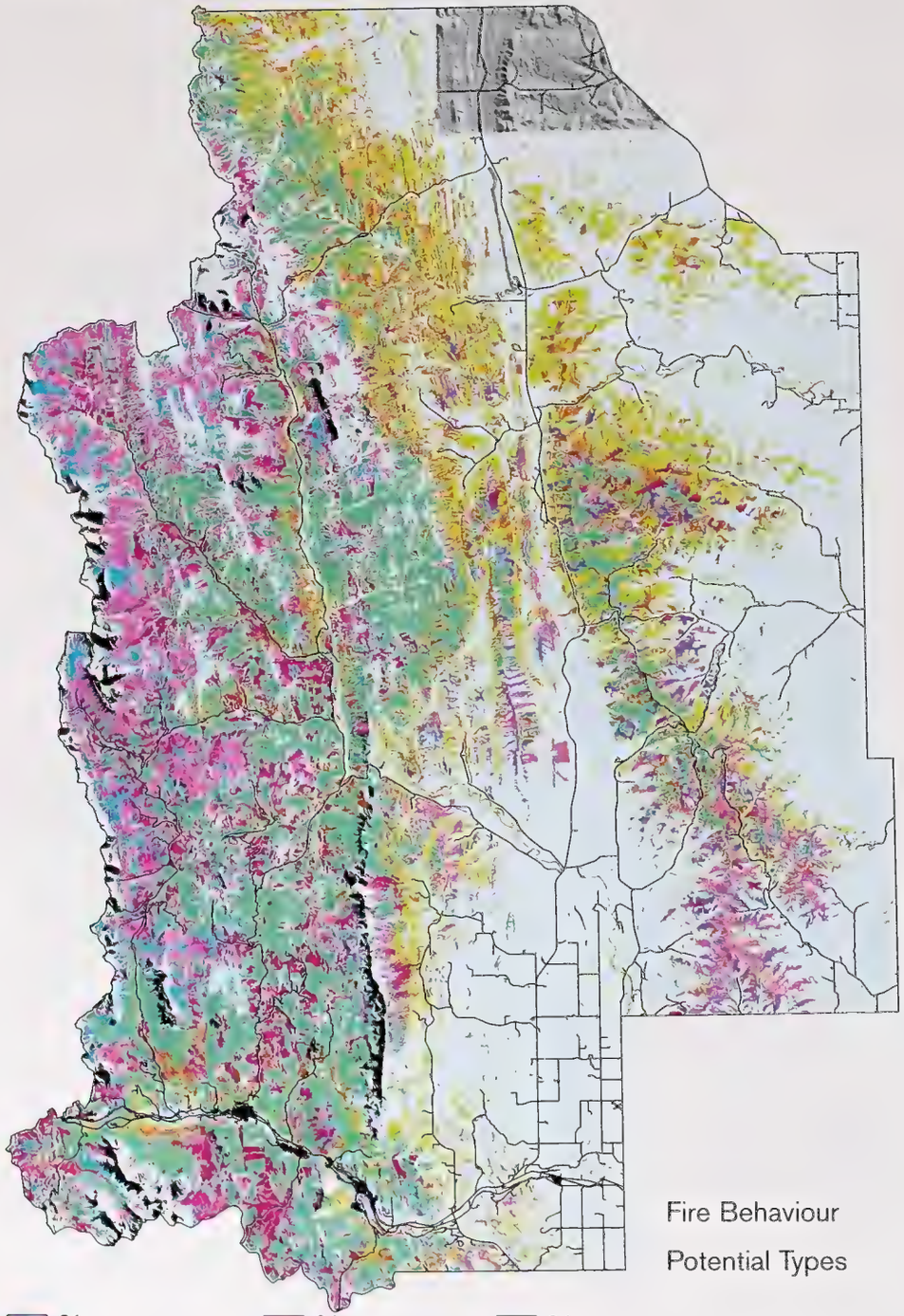
Existing



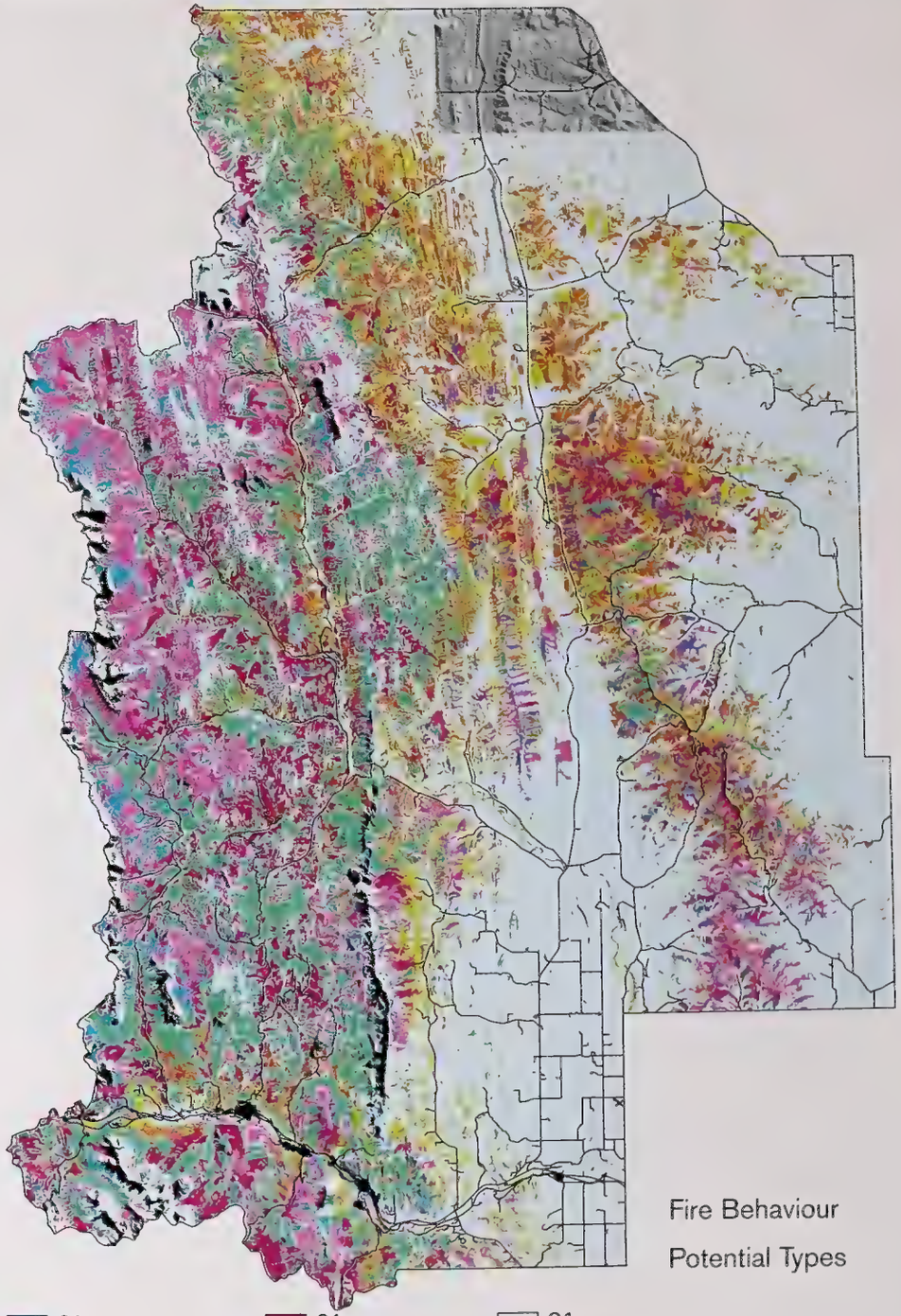
Disturbance



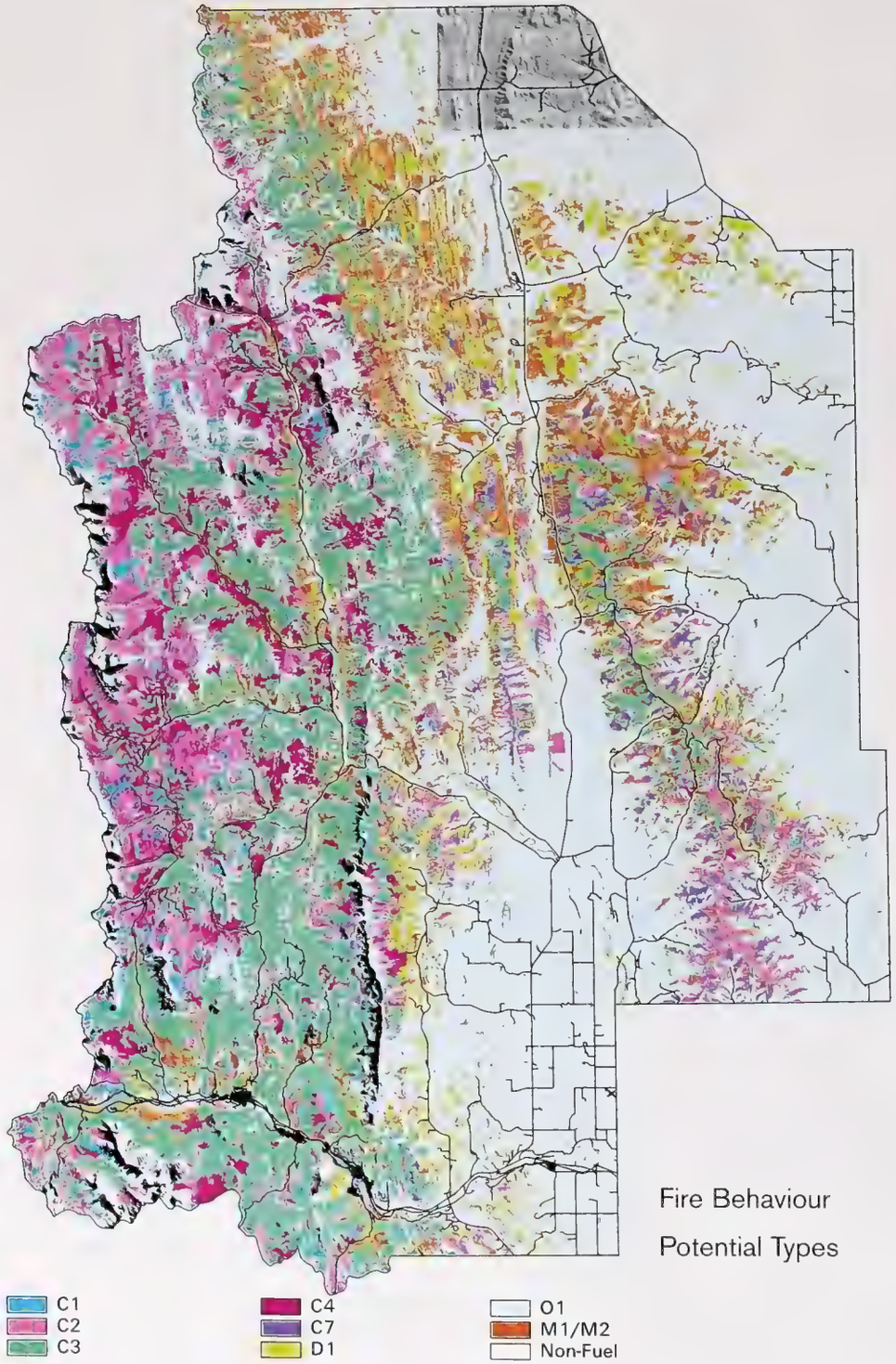
Trend 20



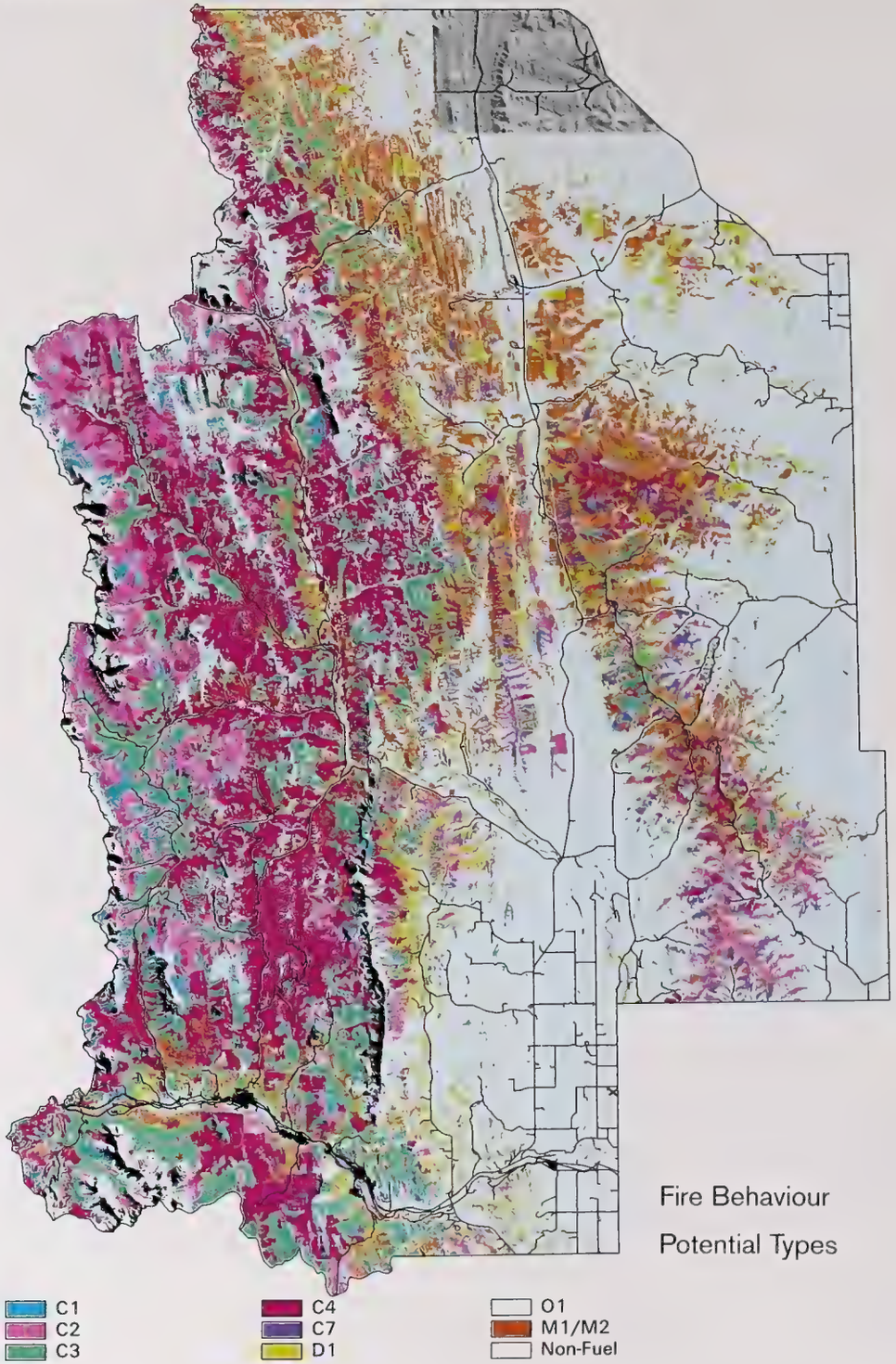
Trend 50



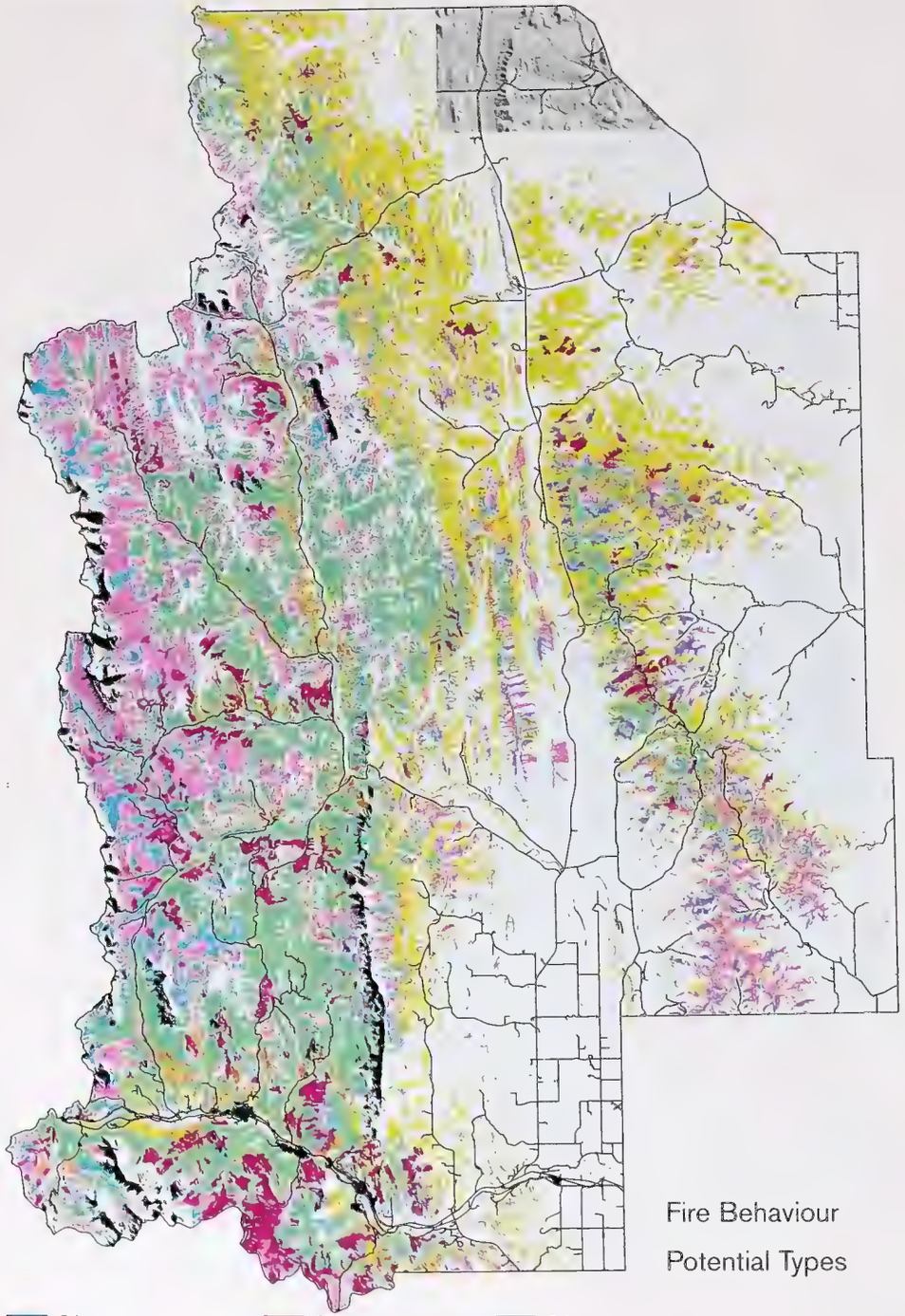
Fibre 20



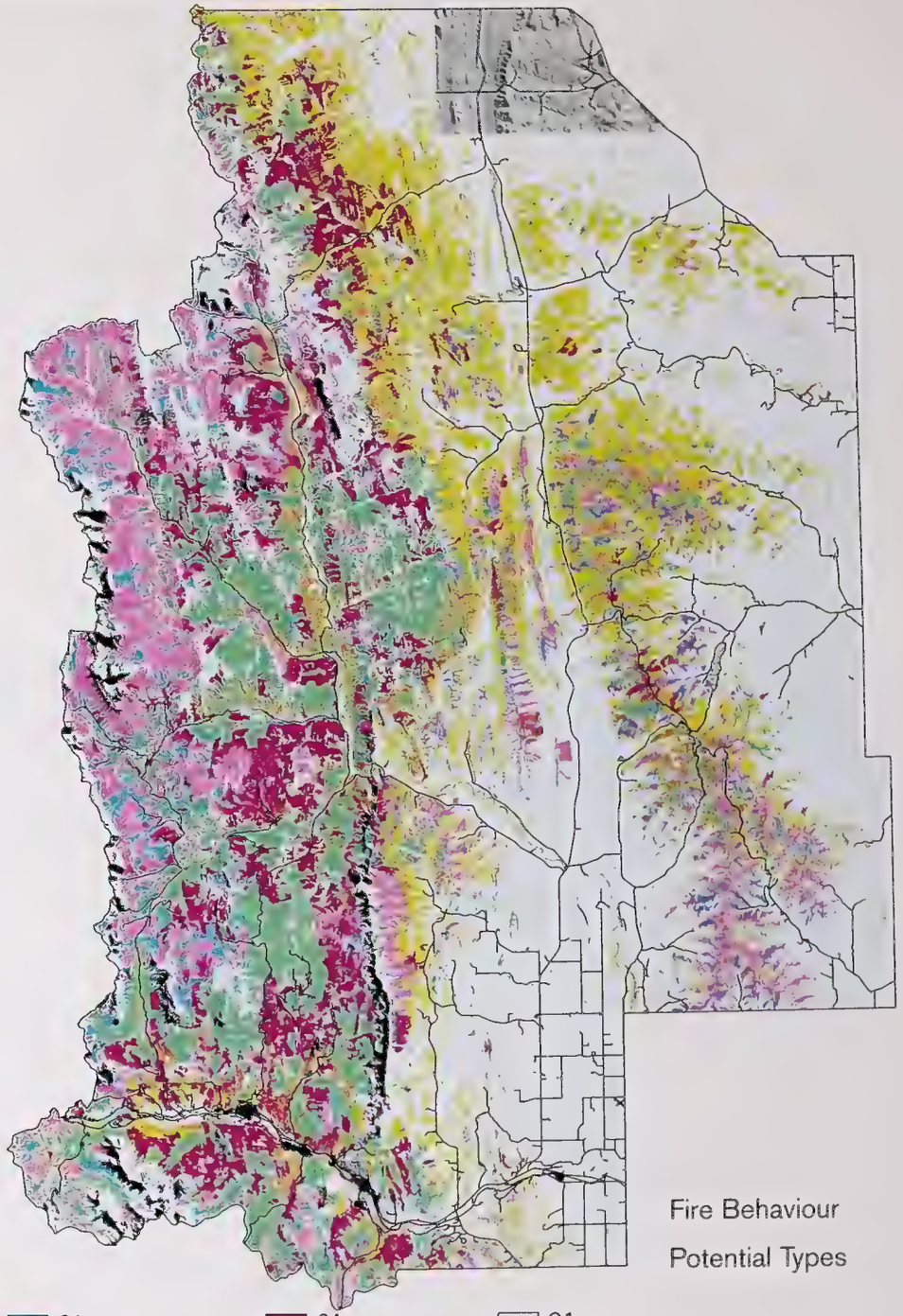
Fibre 50



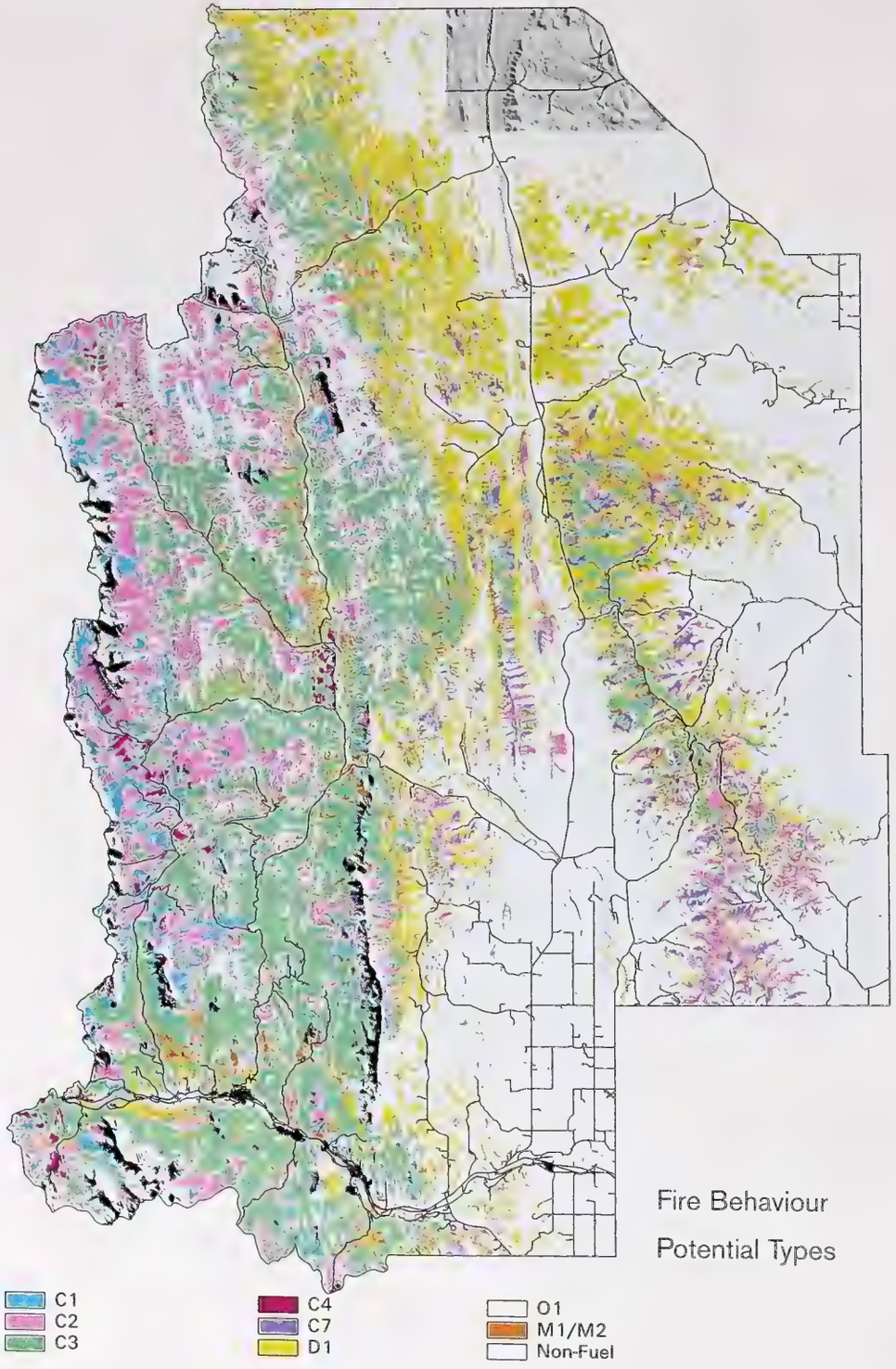
Preservation 20



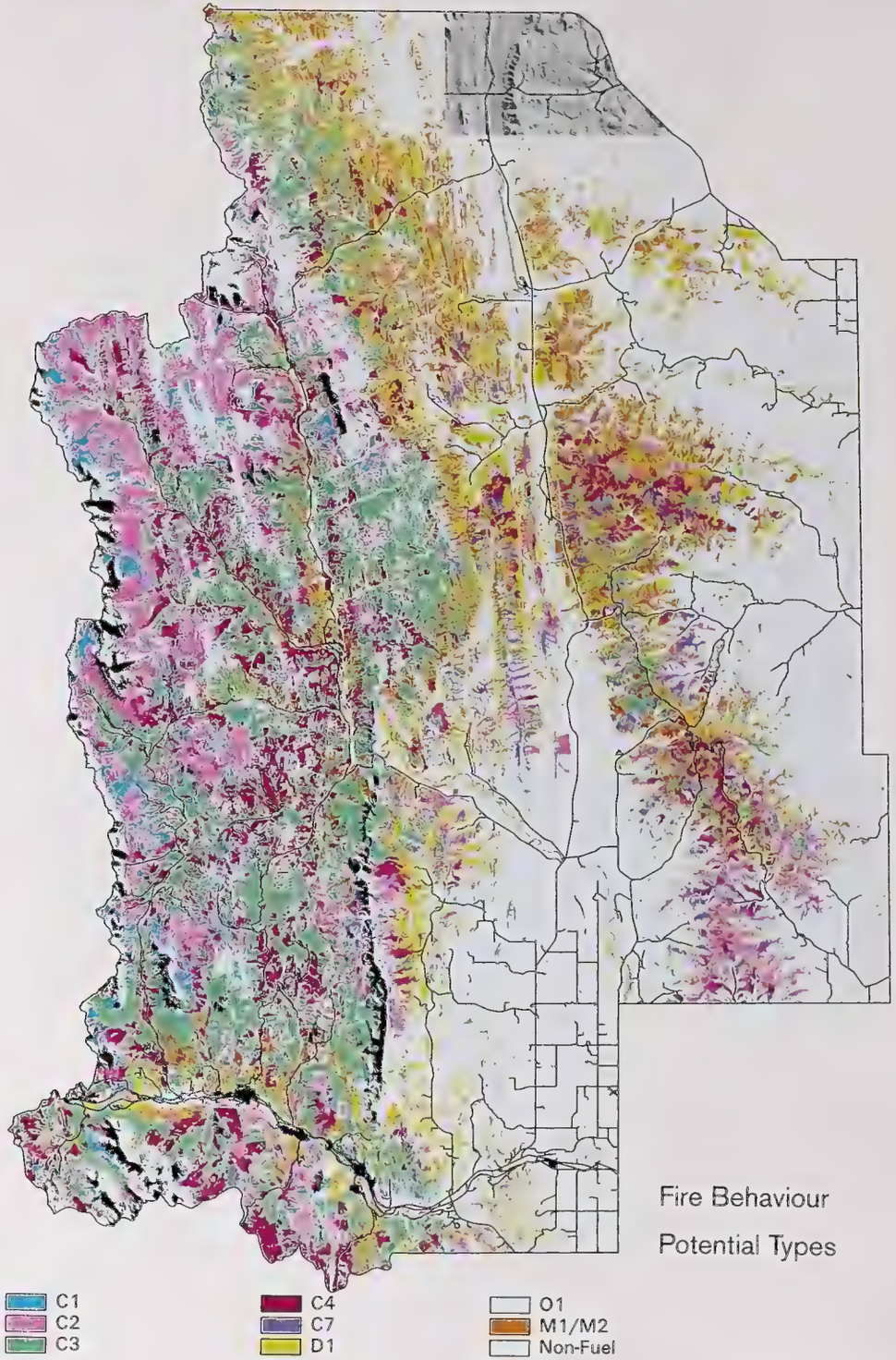
Preservation 50



Recreation 20



Recreation 50



4.1.6.2. HEAD FIRE INTENSITY

Fire behaviour is dependent on fuel, topography and weather. The FBP fuel type modelling only reflects one of these variables. The other two, weather and topography, must be modelled if areas of highest potential fire intensity and the associated risk for the development of large fires are to be spatially identified. The Spatial Fire Management System (SFMS) has been used to model the impact of the various scenarios on Head Fire Intensity (HFI), a measure of the potential energy release. The core SFMS functions have been developed by the Canadian Forest Service with enhanced functionality to the program provided by extensions written by Alberta Environment. The raster (grid based) modelling routines utilize the following input data:

Slope
Slope Azimuth (upslope direction)
Elevation
Fuel Behaviour Potential (FBP) Types (refer to previous section)
Weather surface maps interpolated from weather stations in the area

The maps were all created with a 100 m grid cell resolution. Finer delineation is possible, but substantially increases computing time. Weather surface maps were created for the 80th and 90th percentiles of the weather for spring, summer and fall. Each scenario was run six times (all three seasons for both percentiles). Different percentiles can be chosen by managers, but the 80th and 90th "provide the greatest level of sensitivity to assess fire behaviour potential problem areas" (Fire Management Planning Team, 1998).

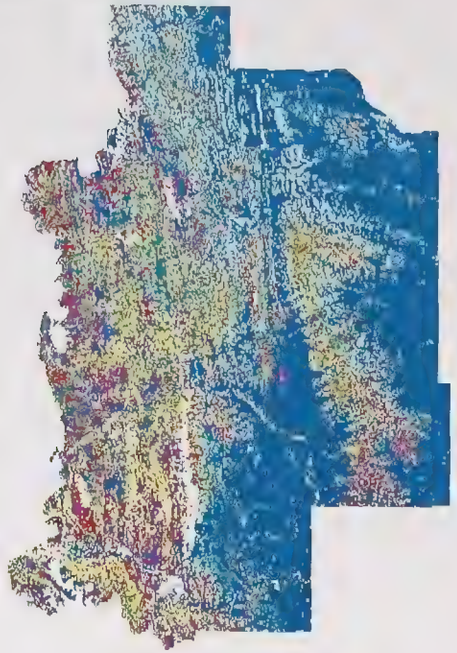
Fire managers can use the head fire intensity models to identify those areas with the greatest potential for large fires and where actions, such as fuel modification, stand conversion, landscape anchor point creation and others, would be most profitably employed.

Under the 90th percentile weather, spring is the time of highest head fire intensity under all scenarios followed closely by fall when potentials are again extremely high. It is significant to note that under the 90th percentile, none of the scenarios appear to significantly reduce HFI potential over all seasons. The potential remains very high for large portions of the area, regardless of the alternative. It should also be noted that none of the alternatives made any attempt to harvest areas with high potential intensities.

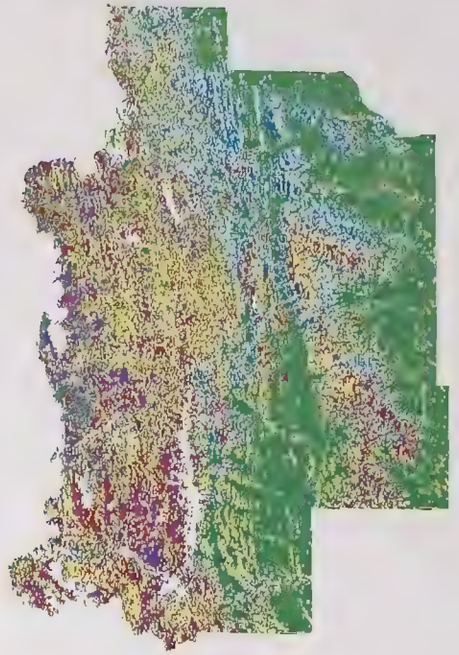
The analysis of the existing conditions indicates that high head fire intensities are found in the Middle Ridges as well as in the grasslands to the east. There are hotspots in areas such as Dutch Creek, Racehorse Creek and others. There are substantial differences in the north and south Porcupine Hills with the southern end of the Hills displaying much greater potential for high intensity fires. In addition, the maps indicate contiguous areas of less intensity that may provide the basis for landscape "anchors" or a compartmental strategy.

Spring – 80th percentile

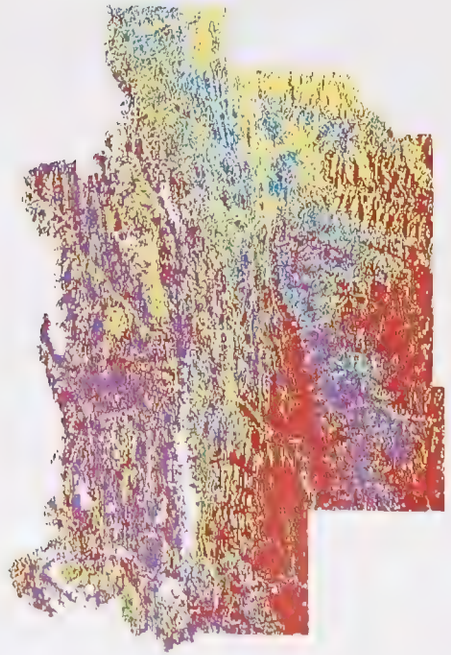
Summer – 80th percentile



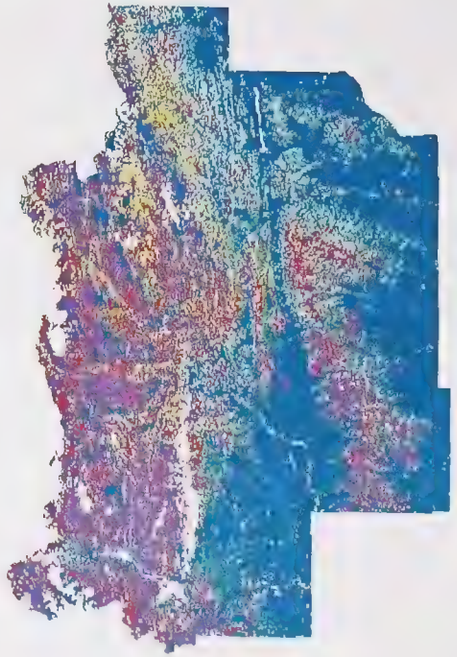
Fall – 80th percentile



Spring – 90th percentile

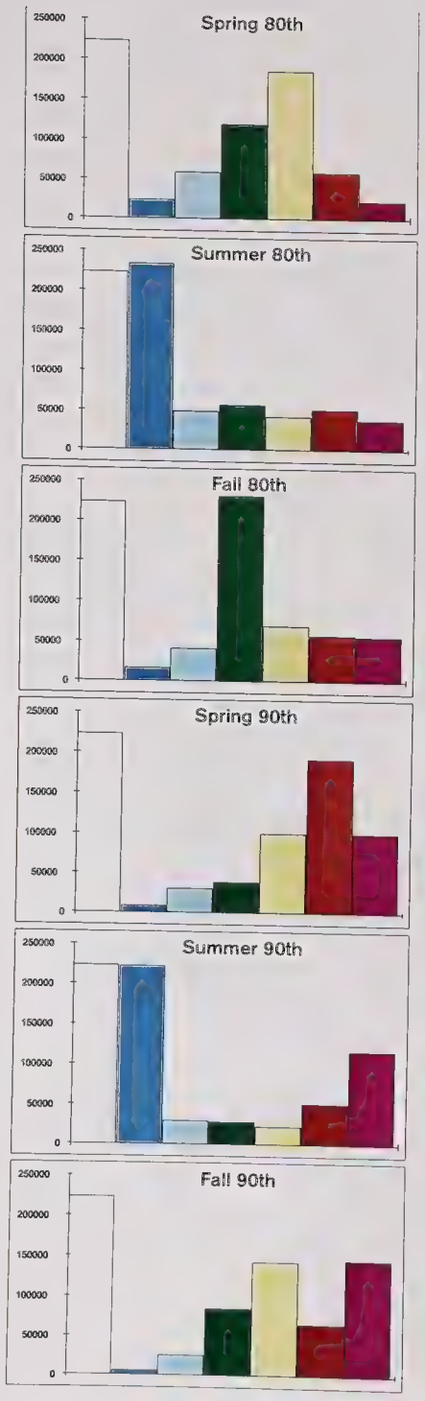


Summer – 90th percentile



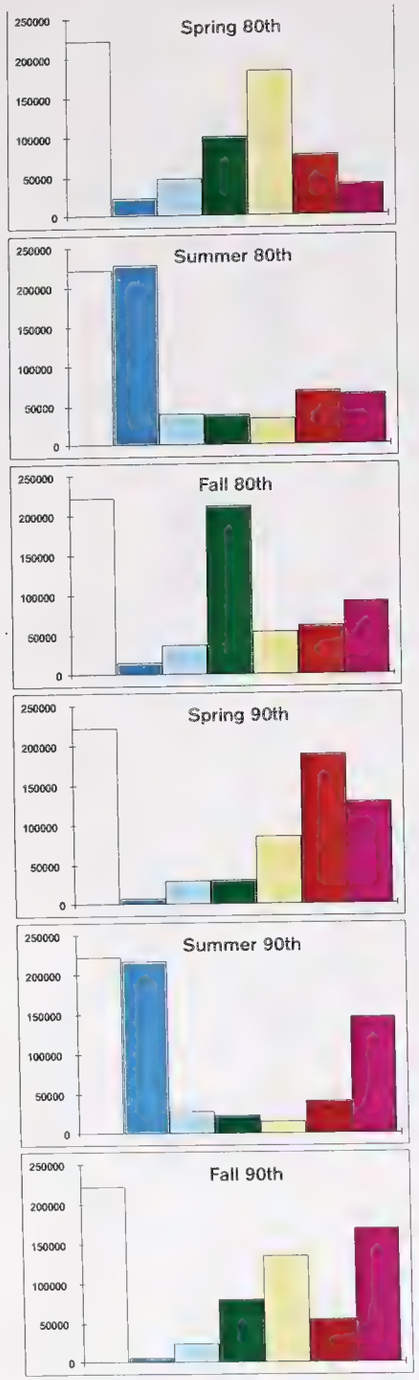
Fall – 90th percentile

Figure 79. **Head Fire Intensity Existing**



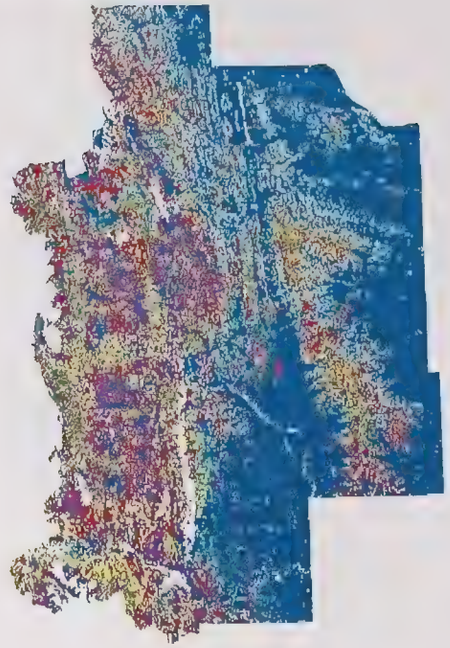
Head Fire Intensity Disturbance

Figure 80.

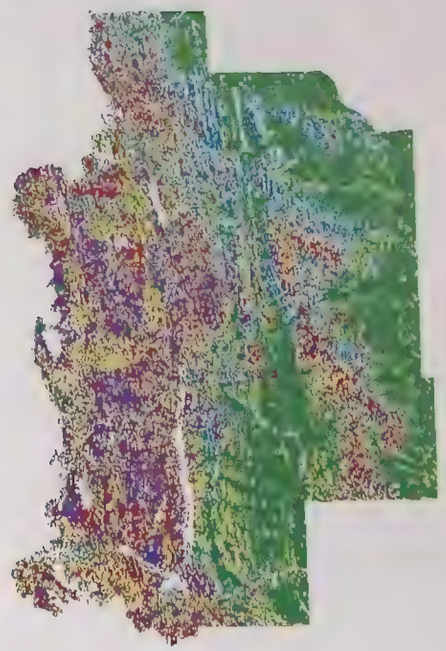


Spring – 80th percentile

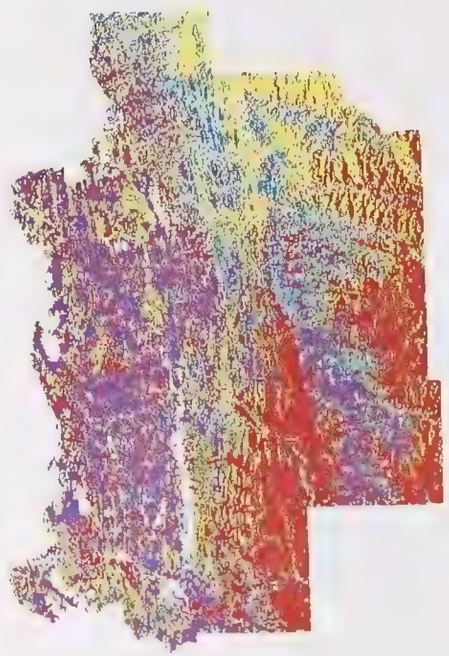
Summer – 80th percentile



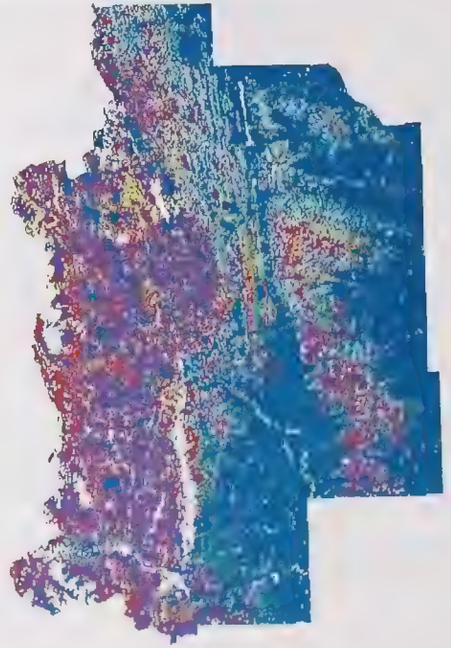
Fall – 80th percentile



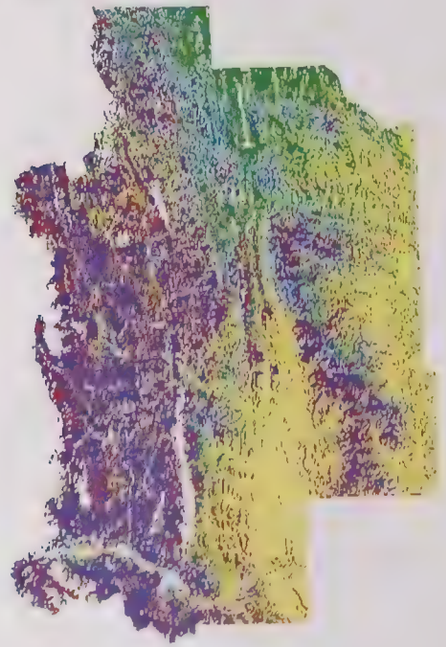
Spring – 90th percentile



Summer – 90th percentile

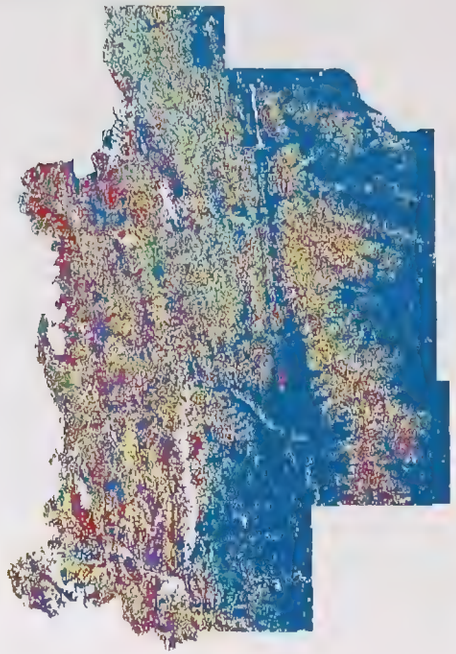


Fall – 90th percentile



Spring – 80th percentile

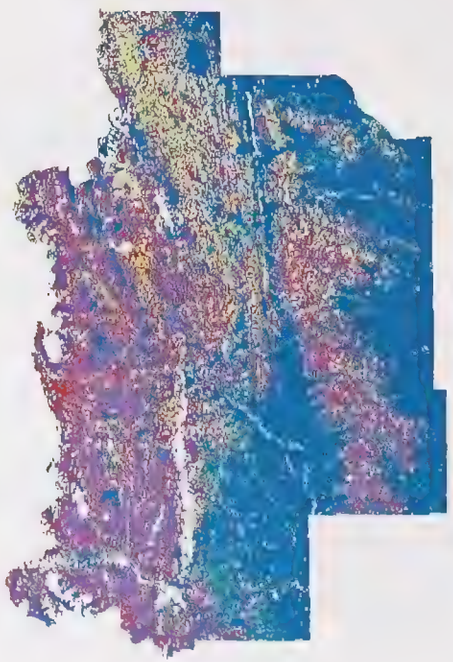
Summer – 80th percentile



Fall – 80th percentile

Spring – 90th percentile

Summer – 90th percentile



Fall – 90th percentile

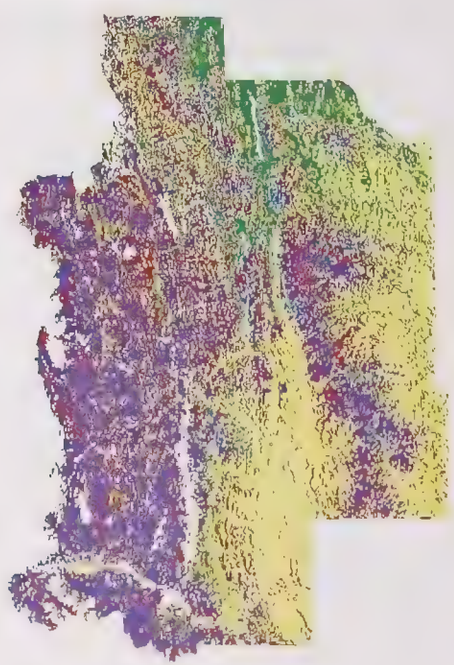
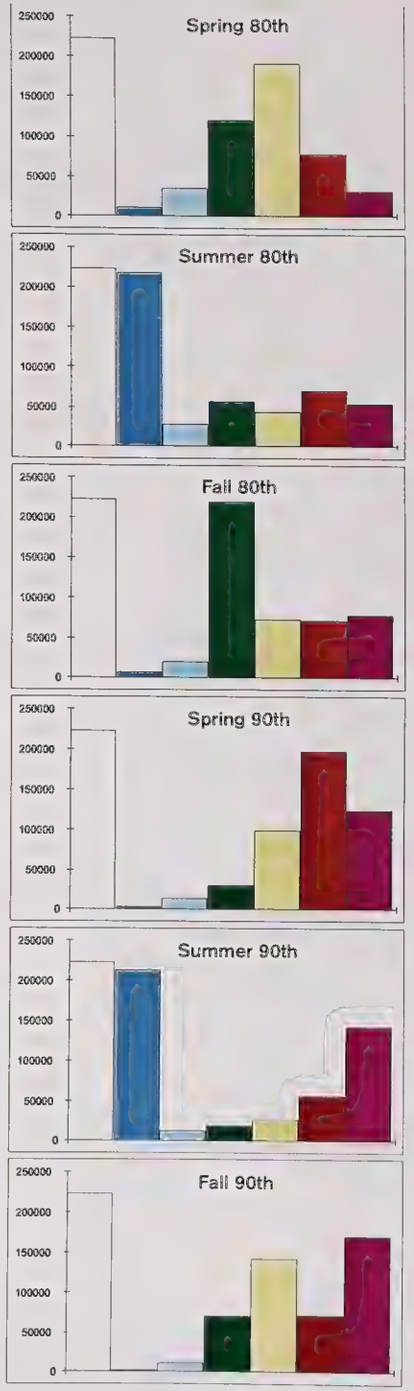
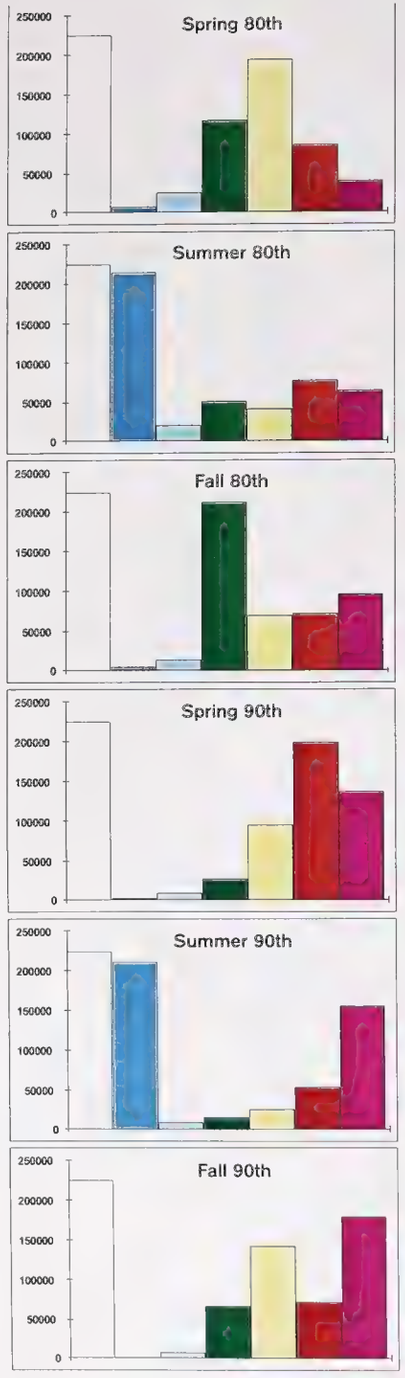


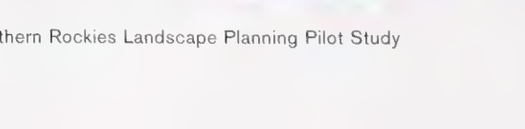
Figure 81. **Head Fire Intensity Trend 50**



Head Fire Intensity
Fibre 50

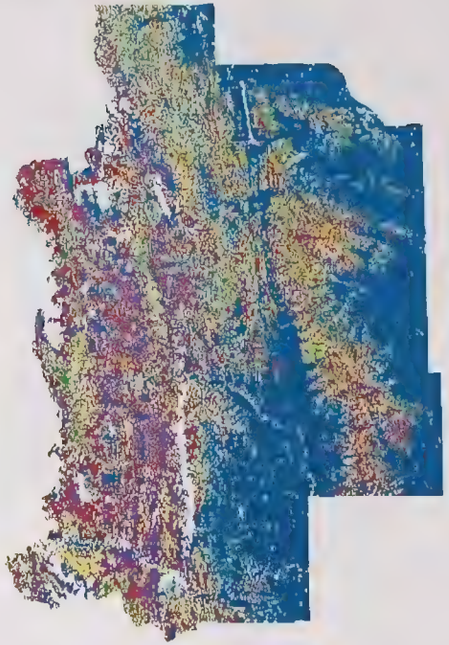
Figure 82.



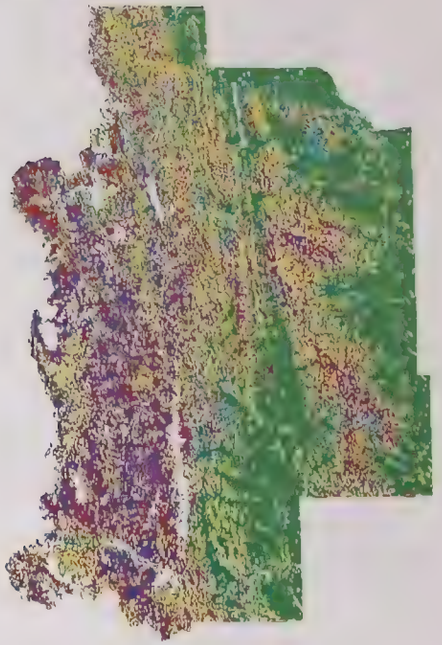


Spring – 80th percentile

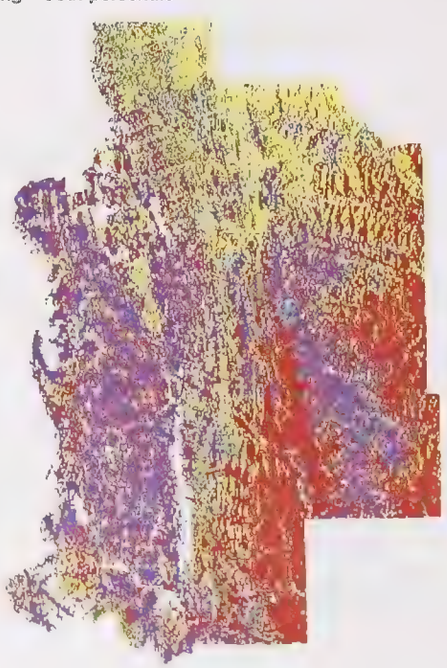
Summer – 80th percentile



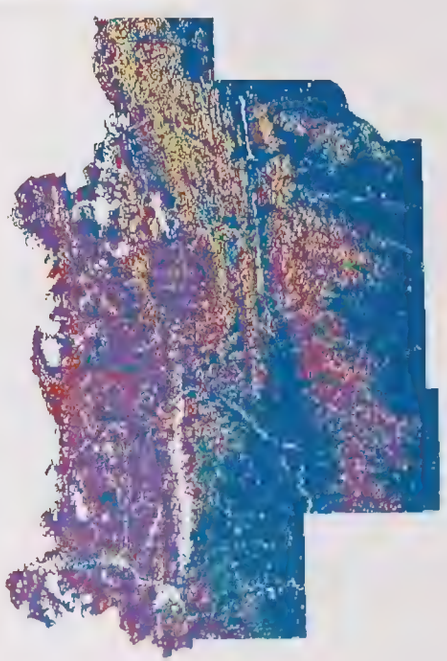
Fall – 80th percentile



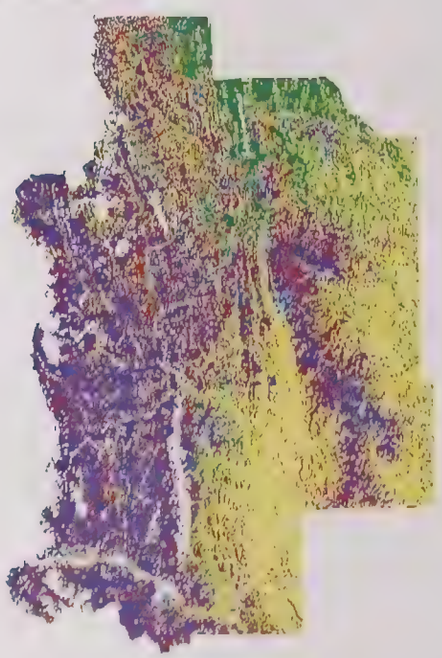
Spring – 90th percentile



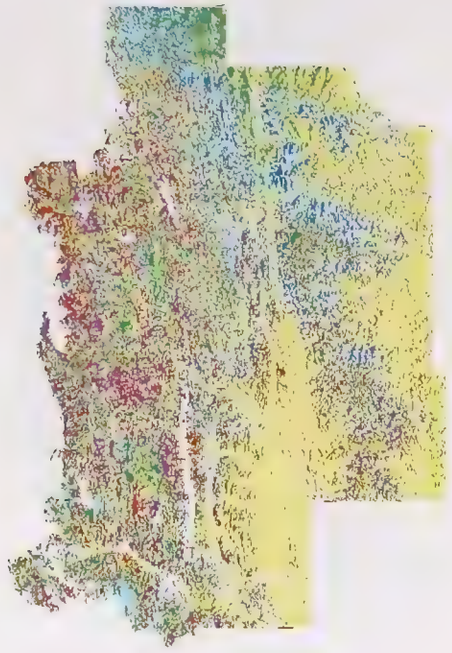
Summer – 90th percentile



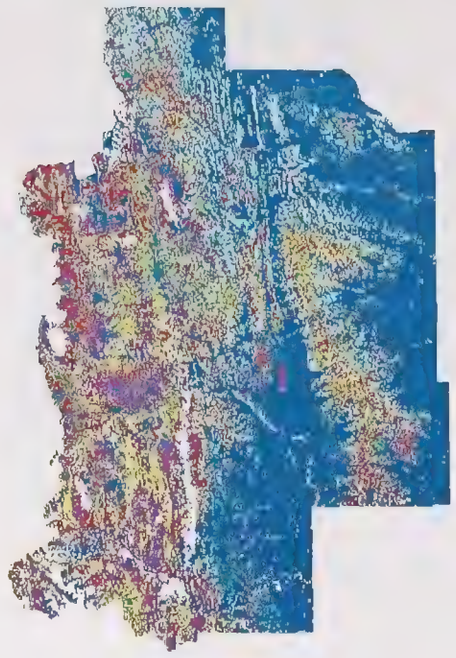
Fall – 90th percentile



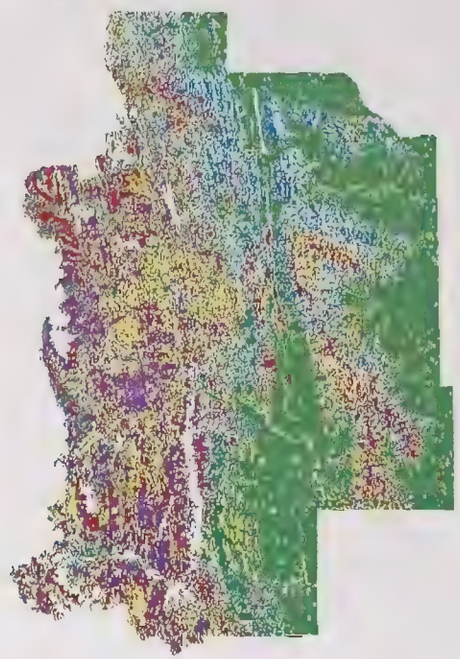
Spring – 80th percentile



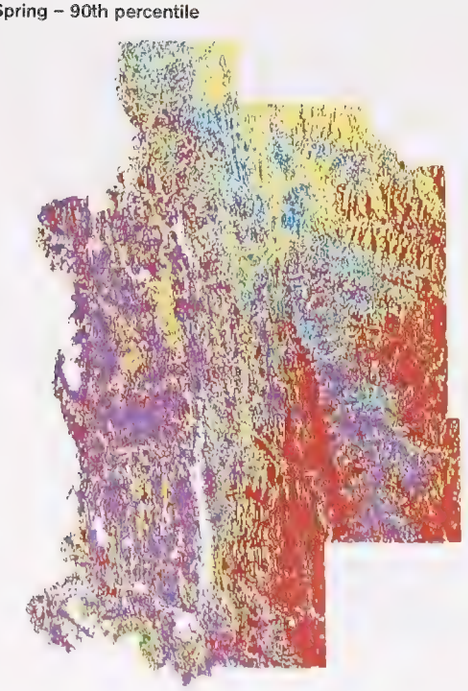
Summer – 80th percentile



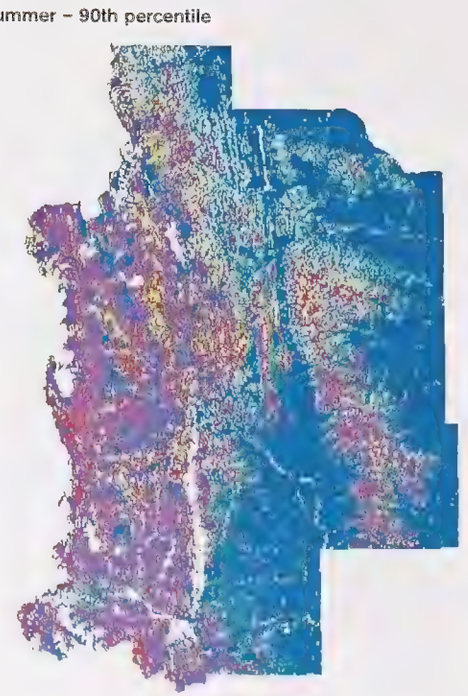
Fall – 80th percentile



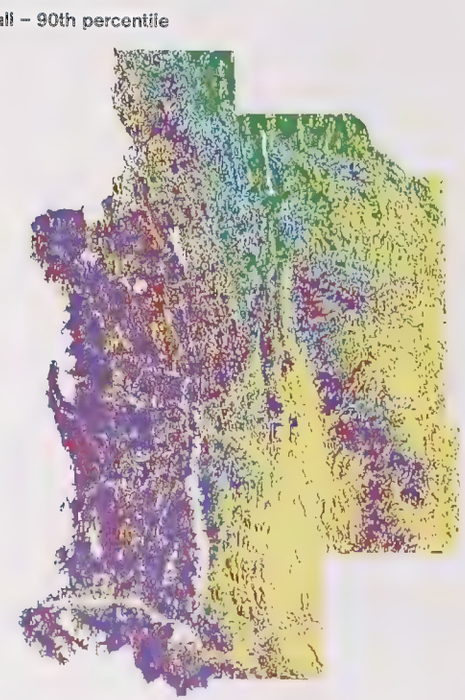
Spring – 90th percentile



Summer – 90th percentile



Fall – 90th percentile



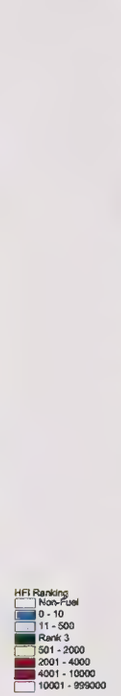
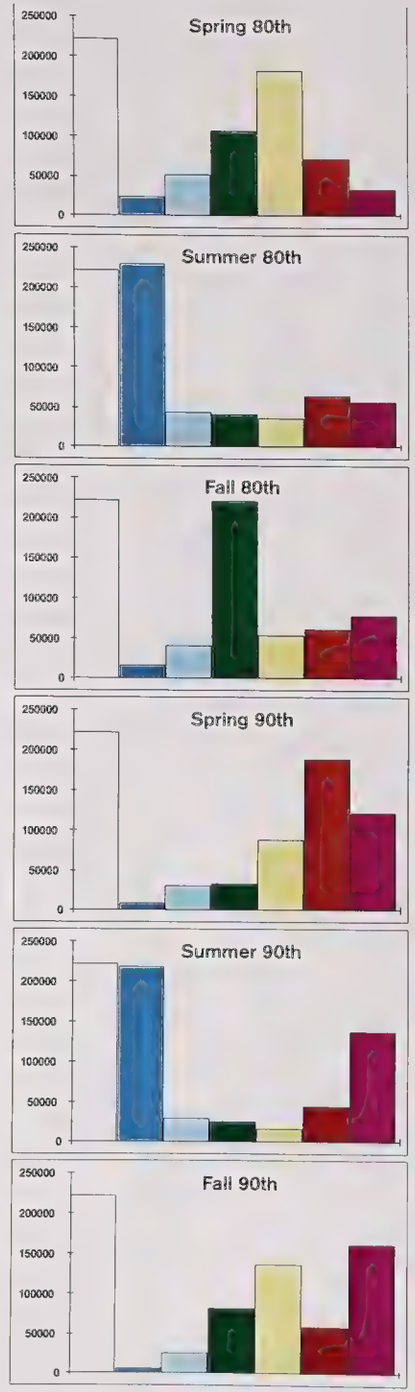
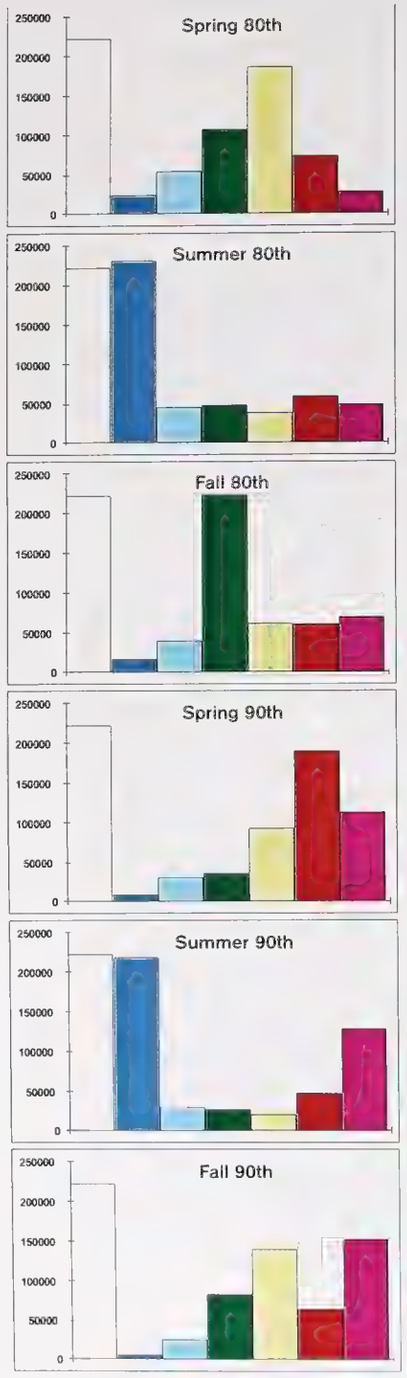


Figure 83. **Head Fire Intensity Preservation 50**



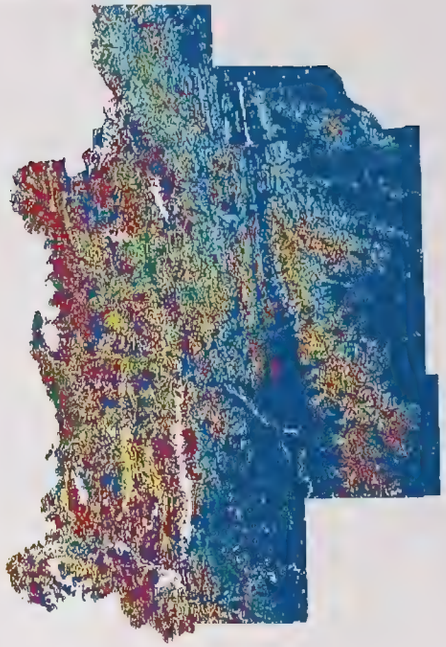
Head Fire Intensity
Recreation 50

Figure 84.

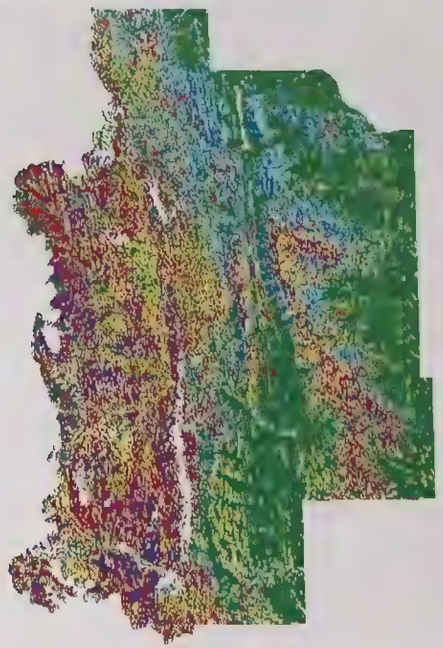


Spring – 80th percentile

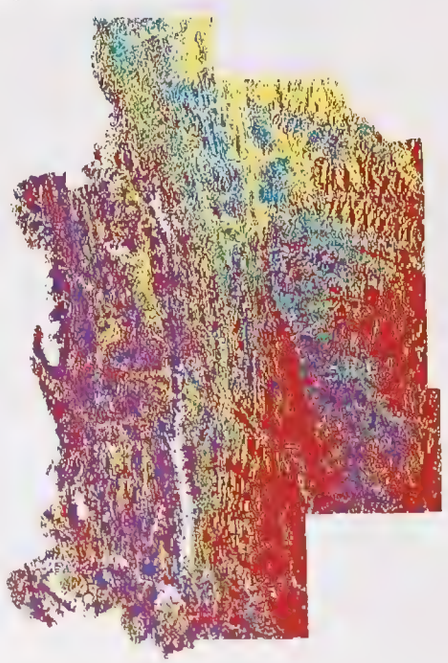
Summer – 80th percentile



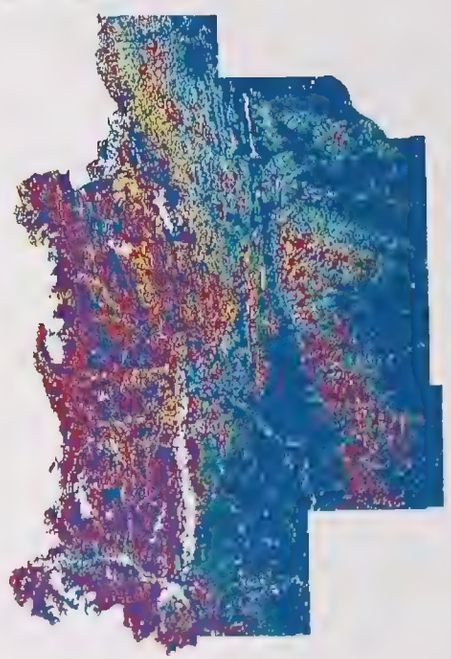
Fall – 80th percentile



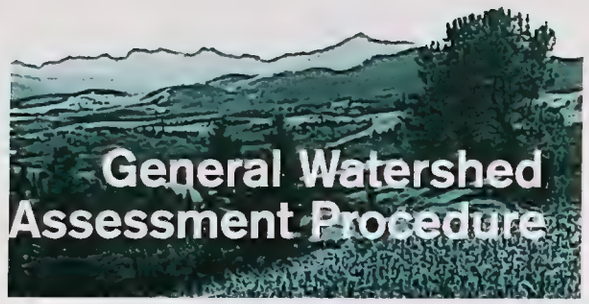
Spring – 90th percentile



Summer – 90th percentile



Fall – 90th percentile



4.1.7. GENERAL WATERSHED ASSESSMENT PROCEDURE

A generalized watershed assessment has been carried out using the Interior Watershed Assessment Procedure (IWAP) originally designed by BC Environment (1995). IWAP is a process designed to determine how forestry–related activities affect natural hydrologic processes. The procedure examines data on elevation, soils, road location, intensity of road use, land stability and various riparian characteristics. One advantage of the IWAP is that it correlates a variety of indicators to assess the relationship between these indicators and specific water related problems and provides a single score card of risk to the basin in terms of erosion and degradation of water quality. It also allows managers to better understand the cumulative impacts of forestry and related industries on the natural environment, and to use this information to create more effective programs for resource management.

The following is an explanation of the implementation of the IWAP process used to complete the analysis of watersheds of the study area. Further detail is found in the Interior Watershed Assessment Procedure Guidebook, published by the Forest Service of British Columbia, September 1995.

The IWAP analyzes information on two levels. On the first level, information from input maps is collected and reprocessed into the information tables, or forms, as described in the IWAP Guidebook. The completed IWAP forms can be analyzed to determine whether or not a second level of analysis is required and to assess how the combined effects have impacted the watershed. The following section outlines the steps of the analysis.

Step One: H60 Map of the Study Area
The initial step in the IWAP process was to create a raster coverage of the study area which spatially locates and identifies those areas above and below the H60 line (the elevation line above which 60% of the watershed area is located). This H60 base map was used to measure access, stream length, fish bearing reaches and other inputs.

Step Two: Area Measurements by Elevation and Sub Basin
The areas above and below H60 areas were calculated.

Step Three: Peak Flow Index
The map created in step one was combined with the Alberta Vegetation Inventory (AVI) to delineate Equivalent Clearcut Areas (ECA). ECA is defined as "the area that has been clearcut with a reduction factor to account for the hydrologic recovery due to forest regeneration" (BC Environment, 1995). The ECA map was then combined with the hydrological map to spatially locate the ECA's in the sub basins. The outputs were used to determine the Peak Flow Index.

Step Four: Road Inventory and Density
Roads above and below the H60 line were located in the basins. Road density calculations were completed.

Step Five: Roads Adjacent to Streams
Areas with a high potential for soil erosion were identified by combining information on soils from the physical land classification with slope. Roads on areas of high potential for erosion were identified.

A distance of 100 m from all rivers and streams was assigned to the H60 vector map created in step one through a "buffering" process. The buffered stream map was overlaid with the road coverage to identify roads located within 100 m of a stream or river. Roads within that zone having a high potential for erosion were also identified.

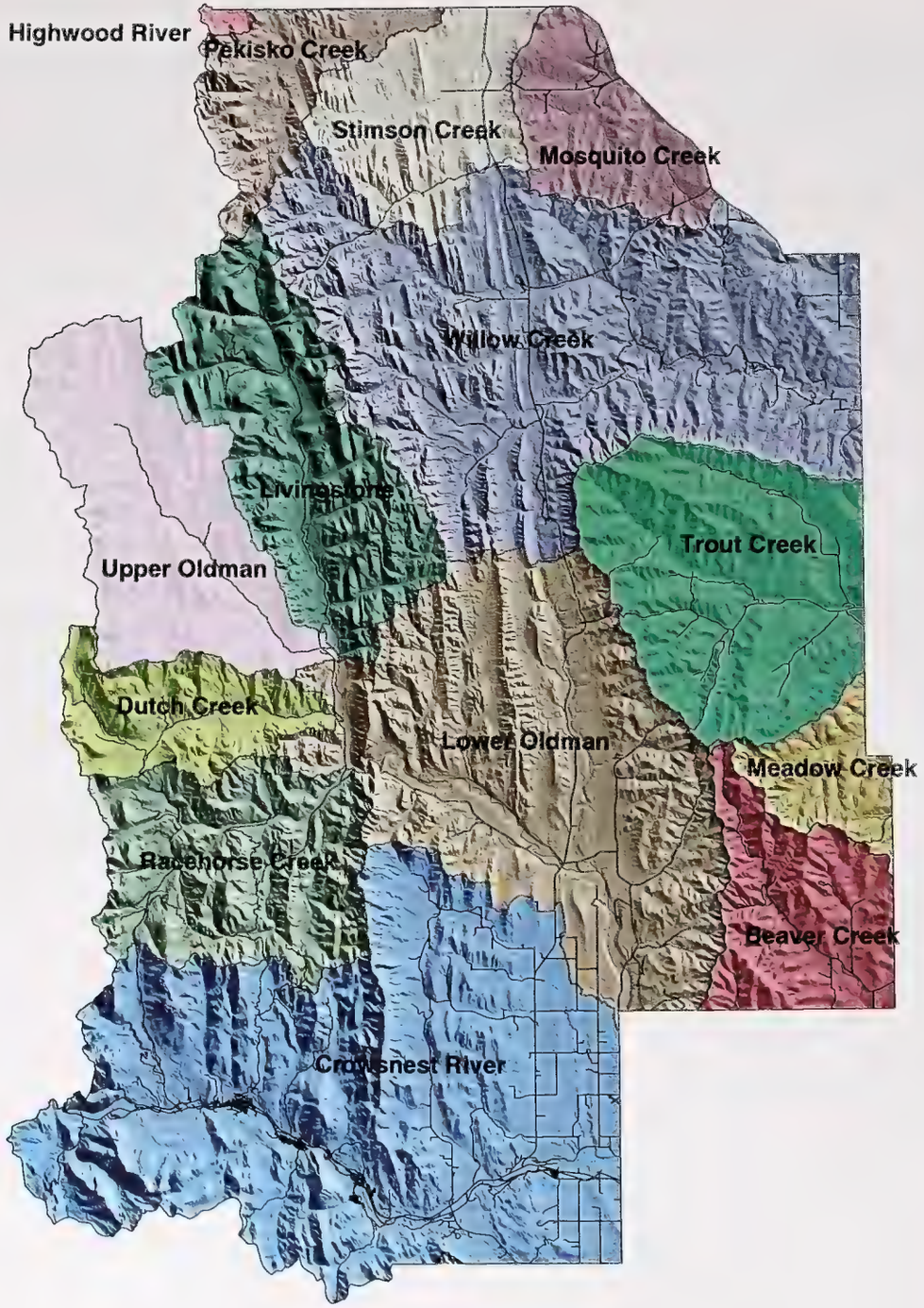
Step Six: Riparian Buffer Impacts
All clearcut areas located on the Alberta Vegetation Index base map were assigned a buffer of 25 m and combined with the H60 vector map to determine which clearcuts are located within 25 m of a river or stream.

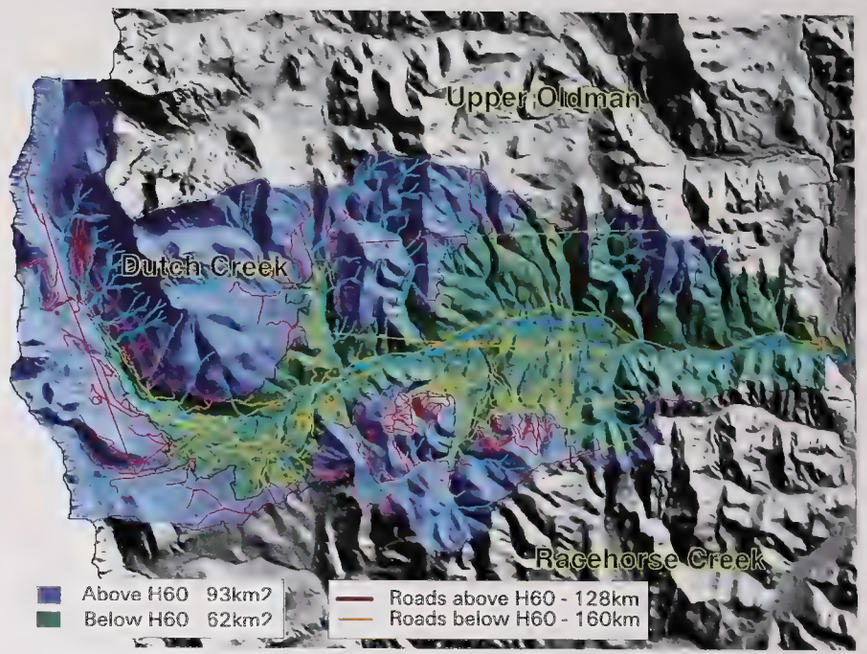
The buffered clearcut map was overlaid with a coverage provided by Mayhood (1998) indicating fish bearing reaches to illustrate the areas of fish bearing streams that have been logged less than 25 m from the stream edge.

Step Seven: The Watershed Report Card
The above analyses were used to determine the level of impact on the watersheds in the study area. The information was summarized as the Watershed report card.

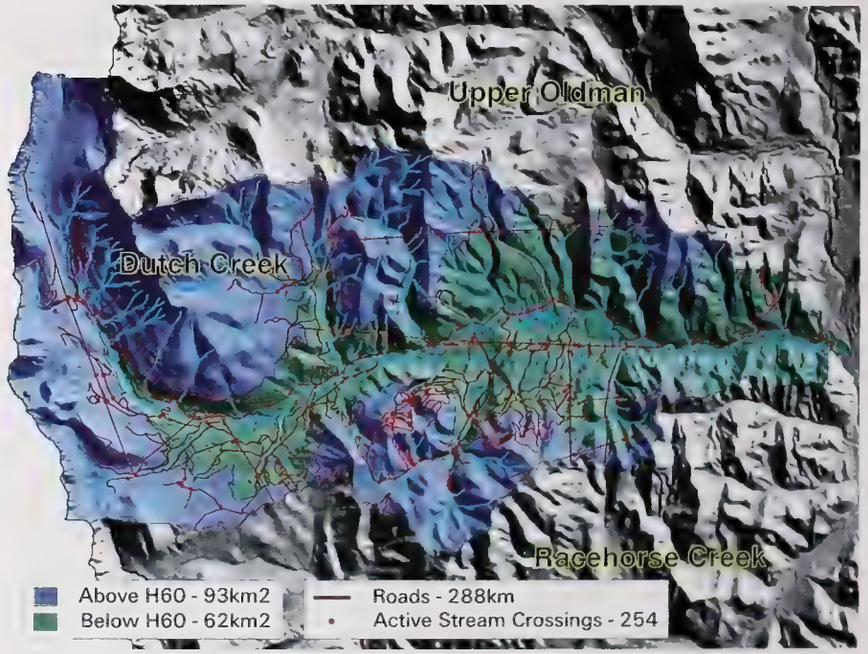
Step Eight: The Hazard Index
The Watershed Report Card was used to determine the Hazard Index for each of the impact categories. The Hazard Index is also used as an analysis tool to assess potential problems with an identified watershed. The index is used to determine which watersheds require further analysis and should be considered for more detailed review.

The IWAP Procedure is helpful in determining thresholds in sub basins for such variables as road densities and harvesting near streamsides, etc. The thresholds may be used for identifying problems and developing recommendations, such as the amount of reclamation required in a basin to bring it within acceptable levels. However, it is not a substitute for peak flow analysis or site specific operational review.





DUTCH CREEK Roads Above and Below H60

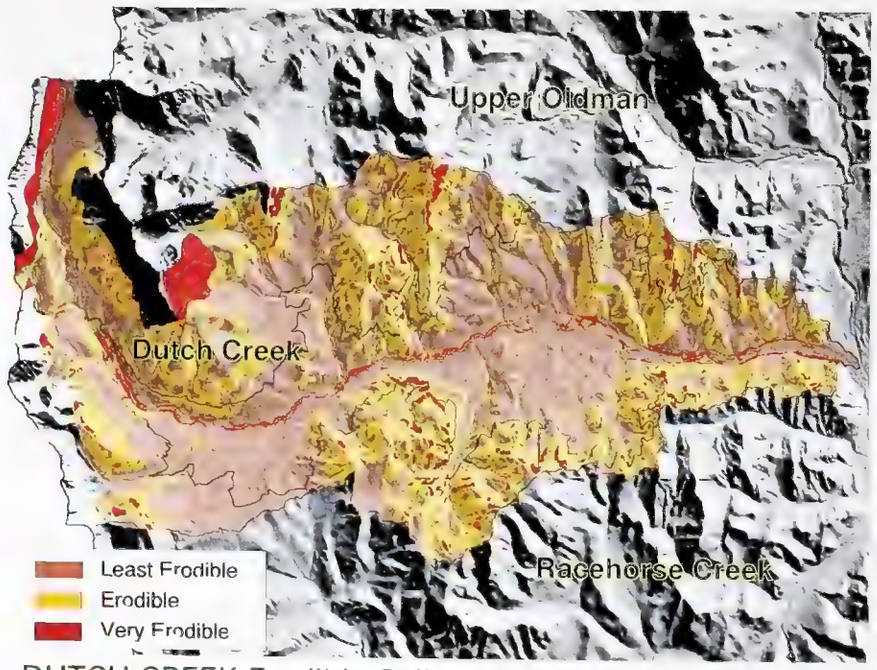


DUTCH CREEK Active Stream Crossings

The watershed assessment procedure has been carried out for all alternatives, however, only the existing conditions and the Trend 20 Scenario are illustrated here. Most basins of interest were chosen as they coincided with areas of concern to fisheries managers. Mass wasting was not included in this analysis. The results indicate whether or not the basin appears to be at risk and if further detailed assessment is required.

The comparison of the existing conditions with results of the Trend 20 analysis indicates significant change in watersheds in several areas. The most extensive change is in the reduction in the quality of riparian buffers under the Trend projection. Several basins are taken to a level two assessment as they have exceeded threshold values in the hazard index. Under the existing conditions, Pekisko Creek, the Highwood River, Willow Creek, Lower Oldman, Beaver Creek, Crowsnest River, Upper Oldman and Racehorse Creek all were assessed as needing additional study and were potentially at risk. Under the Trend 20, Stimson Creek, Dutch Creek and Livingstone are added to the list of basins at potential risk. The Trend Scenario results in a change in the number of basins requiring more detailed study from 8 of the 14 basins to 11. The Preservation Scenario, on the other hand, removes many roads and makes a significant positive impact on basin characteristics.

Note: The authors greatfully acknowledge the provision of a portion of the fisheries data by D. Mayhood.



DUTCH CREEK Erodible Soils

Figure 85. Watershed Assessment

Roads and Soils- Existing

Sub basin name	Sub basin area (km2)	Road on erodible soils Length(km)	Roads on erodible soils Density(km/km2)	Road within 100m of stream Length(km)	Road within 100m of stream on erodible soils Length(km)	Road within 100m of stream on erodible soils Density(km/km2
Mosquito Creek	159.86	49.37	0.31	38.09	11.08	0.07
Stimson Creek	206.66	8.10	0.04	23.61	2.11	0.01
Pekisko Creek	144.26	57.43	0.40	96.80	25.72	0.18
Highwood River	7.19	3.58	0.50	6.26	1.82	0.25
Willow Creek	907.41	500.99	0.55	615.42	152.49	0.17
Lower Oldman	717.58	192.84	0.27	588.39	87.85	0.12
Trout Creek	403.10	69.57	0.17	148.08	26.99	0.07
Meadow Creek	91.48	21.65	0.24	14.55	9.96	0.11
Beaver Creek	200.67	165.00	0.82	145.55	77.28	0.39
Crowsnest River	1055.54	549.35	0.52	793.89	186.55	0.18
Dutch Creek	155.26	7.48	0.05	22.99	4.94	0.03
Upper Oldman	343.18	163.25	0.48	195.90	65.95	0.19
Livingstone	358.29	41.87	0.12	47.98	16.80	0.05
Racehorse Creek	305.36	24.08	0.08	64.06	12.95	0.04

Roads in Basin - Existing

Sub basin name	Sub basin area (km2)	Road above H60 (km)	Road above H60 Density(km/km2)	Road entire sub basin (km)	Road entire sub basin Density(km/km2)
Mosquito Creek	159.86	85.92	0.90	133.17	0.83
Stimson Creek	206.66	16.60	0.13	74.64	0.36
Pekisko Creek	144.26	107.63	1.24	209.73	1.45
Highwood River	7.19	4.31	1.00	11.50	1.60
Willow Creek	907.41	1069.11	1.96	1605.90	1.77
Lower Oldman	717.58	716.67	1.66	1221.03	1.70
Trout Creek	403.10	242.89	1.00	362.94	0.90
Meadow Creek	91.48	23.38	0.43	40.55	0.44
Beaver Creek	200.67	218.43	1.81	323.67	1.61
Crowsnest River	1055.54	1162.31	1.84	2199.33	2.08
Dutch Creek	155.26	4.44	0.05	42.50	0.27
Upper Oldman	343.18	165.73	0.80	395.07	1.15
Livingstone	358.29	53.17	0.25	116.65	0.33
Racehorse Creek	305.36	32.68	0.18	122.72	0.40

Harvesting and Streams - Existing

Sub basin name	Length of stream logged(km)	Total length of stream(km)	Portion of stream logged(km/km)	Length of fish bearing stream logged(km)	Total length of fish bearing stream(km)	Portion of fish bearing stream logged(km/km)
Mosquito Creek	0.00	272.49	0.00	0.00	0.00	0.00
Stimson Creek	5.86	351.37	0.02	0.00	0.00	0.00
Pekisko Creek	10.73	315.51	0.03	0.00	3.43	0.00
Highwood River	0.80	15.67	0.05	0.00	0.00	0.00
Willow Creek	49.03	1933.53	0.03	20.20	52.57	0.38
Lower Oldman	5.08	1558.11	0.00	0.25	48.69	0.01
Trout Creek	0.00	806.49	0.00	0.00	0.00	0.00
Meadow Creek	0.00	175.87	0.00	0.00	0.00	0.00
Beaver Creek	6.32	371.48	0.02	0.00	0.00	0.00
Crowsnest River	17.27	1939.21	0.01	17.04	180.08	0.09
Dutch Creek	7.48	336.80	0.02	7.47	43.74	0.17
Upper Oldman	31.02	780.17	0.04	31.00	96.10	0.32
Livingstone	6.29	784.04	0.01	6.29	89.13	0.07
Racehorse Creek	35.65	696.84	0.05	35.83	83.61	0.43

Stream Crossings - Existing

Sub basin name	Stream crossings Number (no.)	Stream crossings Density (no./km2)
Mosquito Creek	90.00	0.56
Stimson Creek	69.00	0.33
Pekisko Creek	227.00	1.57
Highwood River	15.00	2.09
Willow Creek	1564.00	1.72
Lower Oldman	1335.00	1.86
Trout Creek	274.00	0.68
Meadow Creek	27.00	0.30
Beaver Creek	227.00	1.13
Crowsnest River	2002.00	1.90
Dutch Creek	50.00	0.32
Upper Oldman	459.00	1.34
Livingstone	112.00	0.31
Racehorse Creek	151.00	0.49

Figure 85. Watershed Assessment Cont'd.

Watershed Report Card - Existing

Impact Categories	Mosquito Creek	Stimson Creek	Pekisko Creek	Highwood River	Willow Creek	Lower Oldman	Trout Creek	Meadow Creek	Beaver Creek	Crowsnest River	Dutch Creek	Upper Oldman	Livingstone River	Racehorse Creek
peak flow index	0	0	0	0	0	0	0	0	0	0	0.3	0.1	0	0.2
road density above H60 (km/km2)	0.9	0.1	1	1	1	1	1	0.4	1	1	0	0.8	0.2	0.2
road density for entire sub basin (km/km2)	0.3	0.1	0.5	0.5	0.6	0.6	0.3	0.1	0.5	0.7	0.1	0.4	0.1	0.1
roads on erodible soil (km/km2)	0.6	0.1	0.7	0.8	0.8	0.5	0.3	0.5	1	0.8	0.1	0.8	0.2	0.2
roads within 100m of stream (km/km2)	0.6	0.3	1	1	1	1	0.8	0.4	1	1	0.4	1	0.3	0.5
roads on erodible soil within 100m of stream (km/km2)	0.3	0.1	0.8	1	0.7	0.6	0.3	0.5	1	0.8	0.2	0.8	0.2	0.2
number of stream crossings (no./km2)	0.7	0.4	1	1	1	1	0.8	0.4	1	1	0.4	1	0.4	0.6
road density for entire sub basin (km/km2)	0.3	0.1	0.5	0.5	0.6	0.6	0.3	0.1	0.6	0.8	0.1	0.4	0.1	0.1
portion of stream logged (km/km)	0	0.1	0.1	0.2	0.1	0	0	0	0.1	0	0.1	0.1	0	0.2
portion of fish bearing stream logged (km/km)	0	0	0	0	0.8	0	0	0	0	0.2	0.3	0.6	0.1	0.9

Hazard Index - Existing

Impact Categories	Mosquito Creek	Stimson Creek	Pekisko Creek	Highwood River	Willow Creek	Lower Oldman	Trout Creek	Meadow Creek	Beaver Creek	Crowsnest River	Dutch Creek	Upper Oldman	Livingstone River	Racehorse Creek
Peak Flows	0.40	0.07	0.50	0.50	0.53	0.53	0.43	0.17	0.50	0.57	0.30	0.43	0.10	0.20
Surface Erosion	0.53	0.35	1.00	0.77	1.00	1.00	0.80	0.50	0.87	1.00	0.40	1.00	0.35	0.55
Riparian buffers	0.00	0.10	0.10	0.20	0.10	0.00	0.00	0.00	0.10	0.20	0.30	0.60	0.10	0.90

Watershed Report Card - TREND 20

Impact Categories	Mosquito Creek	Stimson Creek	Pekisko Creek	Highwood River	Willow Creek	Lower Oldman	Trout Creek	Meadow Creek	Beaver Creek	Crowsnest River	Dutch Creek	Upper Oldman	Livingstone River	Racehorse Creek
peak flow index	0	0.2	0.1	0.2	0.1	0.1	0.1	0	0	0.1	0.2	0.2	0.1	0.2
road density above H60 (km/km2)	0.9	1	1	1	1	1	1	0.4	1	1	1	0.9	0.8	1
road density for entire sub basin (km/km2)	0.3	0.6	0.5	0.6	0.6	0.6	0.3	0.1	0.5	0.7	0.7	0.4	0.4	0.7
roads on erodible soil (km/km2)	0.6	0.9	0.7	0.8	0.9	0.5	0.4	0.5	1	0.8	0.9	0.8	0.8	0.9
roads within 100m of stream (km/km2)	0.6	1	1	1	1	1	0.9	0.4	1	1	1	1	1	1
roads on erodible soil within 100m of stream (km/km2)	0.3	0.8	0.8	1	0.7	0.6	0.4	0.5	1	0.8	1	0.9	1	0.9
number of stream crossings (no./km2)	0.7	1	1	1	1	1	0.9	0.4	1	1	1	1	1	1
road density for entire sub basin (km/km2)	0.3	0.7	0.5	0.6	0.6	0.6	0.3	0.1	0.6	0.8	0.7	0.4	0.4	0.8
portion of stream logged (km/km)	0	0.3	0.2	0.5	0.2	0.1	0.1	0	0.1	0.2	0.5	0.4	0.3	0.5
portion of fish bearing stream logged (km/km)	0	0	1	0	1	1	0	0	0	1	1	1	1	1

Hazard Index - TREND 20

Impact Categories	Mosquito Creek	Stimson Creek	Pekisko Creek	Highwood River	Willow Creek	Lower Oldman	Trout Creek	Meadow Creek	Beaver Creek	Crowsnest River	Dutch Creek	Upper Oldman	Livingstone River	Racehorse Creek
Peak Flows	0.40	0.60	0.53	0.60	0.57	0.57	0.47	0.17	0.50	0.60	0.63	0.50	0.43	0.63
Surface Erosion	0.53	1.00	1.00	0.80	1.00	1.00	0.90	0.50	0.87	1.00	0.67	1.00	0.73	1.00
Riparian buffers	0.00	0.30	1.00	0.50	1.00	1.00	0.10	0.00	0.10	1.00	1.00	1.00	1.00	1.00

Watershed Assessment

Sub-basin	EXISTING Level 2 Assessment Required	TREND20 Level 2 Assessment Required
Mosquito Creek	NO	NO
Stimson Creek	NO	YES
Pekisko Creek	YES	YES
Highwood River	YES	YES
Willow Creek	YES	YES
Lower Oldman	YES	YES
Trout Creek	NO	NO
Meadow Creek	NO	NO
Beaver Creek	YES	YES
Crowsnest River	YES	YES
Dutch Creek	NO	YES
Upper Oldman	YES	YES
Livingstone	NO	YES
Racehorse Creek	YES	YES

4.1.8. WRENNS ANALYSIS

Timber harvests throughout the world have been shown to increase the water yield from affected watersheds. In Alberta, timber harvest on the Weldwood Canada Forest Management Agreement (FMA) area near Hinton, Alberta, was shown to increase annual water yield from a number of watersheds by 39 mm or about 25% in 1974 (Swanson and Hillman, 1977). In general, timber harvests are not planned, with respect to intensity or frequency of watershed re–entry, with regard to their possible changes to water yield and peak flows. One of the goals of forestry programs across Canada is to obtain better integration of forest operations with other users of the land and water resources. To this end, the water yield impacts should be addressed during the planning phase of timber extraction from any area.

Alberta Environment has concluded that water yield increases less than 15% of the average annual flow are not likely to cause significant change in downstream flood characteristics. Fisheries biologists have concluded that velocities critical to the movement of bed material can occur during approximately 25% – 30% of the incubation cycle (May through September) of rainbow trout in the Tri–Creeks watershed. From this, and perhaps other information, some fisheries biologists have suggested that the stream flow peaks that occur approximately every 10 years are responsible for much of the stream bed movement in streams within the Foothills Model Forest area. Although there does not appear to be a definitive study relating flood recurrence and fish habitat condition, the above observations may provide a general criterion for examining the effects of timber harvest on streamflow in any area. That is, the hydrology of a watershed with actual or predicted harvest causing a significant increase in the magnitude of the 2–, 5–, and 10–year event, or an increase in the frequency of these events, should be examined in more detail.

In order to understand the potential hydrological impacts of the scenarios, three analytical scales of analysis were selected. These are:
1. three small catchments in the Upper Oldman of approximately 10 km^2 each
2. the entire Livingstone Drainage (approximately 358 km^2)
3. the Oldman Basin within the study area (1,880 km^2)

There is public concern that harvesting may be increasing peak flows substantially at the broad scale and contributing to serious flooding. Most hydrologists agree that the current levels of harvesting are unlikely to elicit such a response. However, it is a strong public concern and, therefore, should be addressed in the modelling.

Small Catchments Analysis

The effect of alternative land use scenarios on water yield and peak flow in the Upper Oldman River watershed was examined. The criteria outlined above have been applied to the flows predicted with the WRENNS procedure (USEPA, 1980) and a hydrologic analysis of streamflow in the Oldman River basin. Three small catchments in the Upper Oldman basin were chosen as samples for analysis; Upper Oldman 1, 7.01, and 11.02. All three of these sample catchments are approximately 10 km in area. Five scenarios were examined for each catchment. These are: Disturbance, Fibre, Preservation, Recreation and Trend. The hydrologic impacts related to each of these scenarios is shown in Table 6 as percentages, and in Table 7 as absolute increases in peak daily and peak instantaneous flow. The Fibre and Preservation Scenarios as applied to catchment 11.02 are the only ones that need to be examined in greater detail for their effects on instream or downstream water users.

Percentage increases are often misleading and are subject to manipulation to suit the end user of the data, (i.e., one can choose between alternative base values to make the percentages as high or as low as desired). For the simulations displayed in Table 6, the average annual yield from the Marmot Creek Experimental Watershed, 364 mm was used. These data represent a 9.4 km^2 catchment of similar altitude and topographic characteristics to the Upper Oldman over a period of 32 years and are some of the highest quality data available for Alberta. Dutch Creek could have been chosen with an annual yield of 274 mm, or the Highwood River (annual yield 519 mm) with comparably higher and lower percentage increases in annual yield. The choice of Marmot was based on its similarity in topography, area and the quality of the data.

One advantage of the percent changes is that the site does not need to be examined in order to get an indication of impact. Alberta Environment's criterion "15% of average annual yield" can be applied to any harvesting activity on any watershed. It is a useful first approximation of effects. With respect to the simulations from the Upper Oldman, all of the scenarios that increase the average annual yield by more than 6% to 8% should probably be viewed with suspicion as the percentage increase would be considerably greater in lower water yield years.

Figure 86. Graphical Model of WRENNS Input Data Preparation

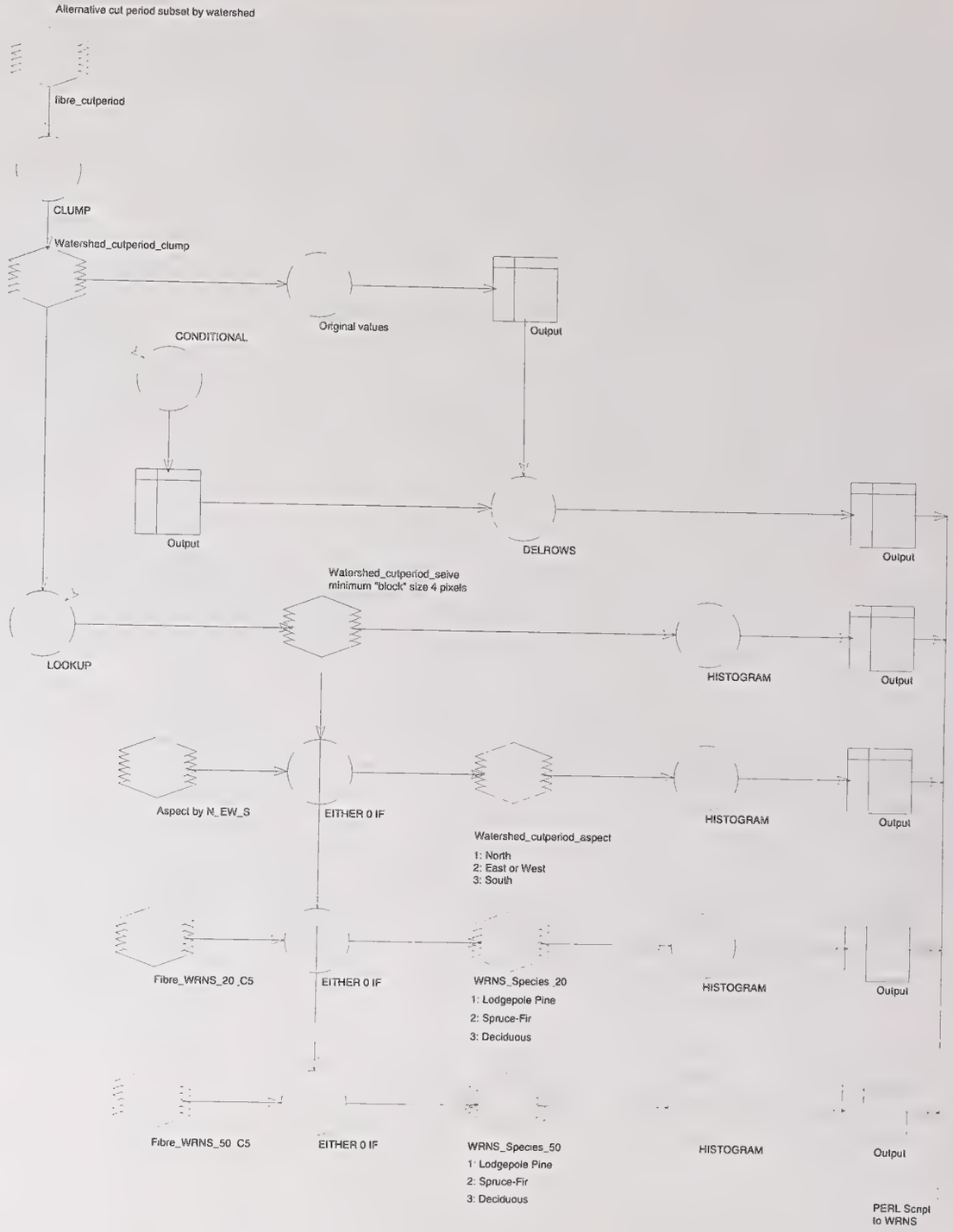


Table 6. Maximum Annual Effects of Scenarios On Water Yield in Small Basins (over 50 years)

Maximum annual effects of land use scenarios on water yield (absolute and percentage) and percent change in peak flows at 1-, 5-, and 10-year recurrence intervals.									
Scenario	Yield Increase		Year of Max	Percent Increase in Daily Peak Flow			Percent Increase in Instantaneous Peaks		
	Mm	%		2-Yr	5-Yr	10-Yr	2-Yr	5-Yr	10-Yr
Upper Oldman Catchment 1									
Disturbance	17.1	4.7	2008	5.2	5.6	6.0	5.2	6.1	6.7
Fibre	19.1	5.3	2043	5.5	5.8	6.3	5.6	6.7	7.5
Preservation	8.8	2.4	2023	2.8	3.0	3.1	2.7	3.2	3.4
Recreation	5.8	1.6	2013	1.7	1.9	2.0	1.7	2.1	2.3
Trend	12.4	3.4	2013	3.5	3.6	4.0	3.5	4.3	4.9
Upper Oldman Catchment 7.01									
Disturbance	16.5	4.5	2008	5.5	5.9	6.2	5.4	6.0	6.4
Fibre	23.0	6.3	2038	6.6	7.0	7.5	6.7	8.0	9.0
Preservation	11.2	3.1	2028	3.4	3.7	3.9	3.4	4.0	4.4
Recreation	1.8	0.5	2043	0.6	0.6	0.6	0.6	0.6	0.7
Trend	9.4	2.6	2033	2.6	2.8	3.0	2.7	3.3	3.7
Upper Oldman Catchment 11.02									
Disturbance	9.5	2.6	2016	3.3	3.6	3.7	3.2	3.5	3.7
Fibre	51.2	14.1	2028	15.3	16.3	17.6	15.4	18.1	20.0
Preservation	38.7	10.6	2047	12.1	13.0	13.8	12.0	13.9	15.1
Recreation	15.1	4.2	2023	4.5	4.8	5.1	4.5	5.3	5.9
Trend	28.3	7.8	2043	7.9	8.3	9.1	8.1	9.8	11.1

Table 7. Maximum Effect of Scenarios on Peak Flows in Small Basins (over 50 years)

Maximum effect of land use scenarios on the absolute values of the maximum daily and maximum instantaneous peak flows.							
Scenario	Year of Max	Increase in Daily Peak Flow, m3/s			Increase in Instantaneous Peaks Flow, m3/s		
		2-Yr	5-Yr	10-Yr	2-Yr	5-Yr	10-Yr
Upper Oldman Catchment 1							
Disturbance	2008	0.01	0.02	0.02	0.08	0.15	0.21
Fibre	2043	0.06	0.11	0.15	0.08	0.16	0.23
Protection	2023	0.03	0.05	0.07	0.04	0.08	0.11
Recreation	2013	0.02	0.03	0.05	0.03	0.05	0.07
Trend	2013	0.04	0.07	0.09	0.05	0.10	0.15
Upper Oldman Catchment 7.01							
Disturbance	2008	0.03	0.06	0.08	0.05	0.08	0.11
Fibre	2038	0.06	0.29	0.40	0.23	0.43	0.60
Protection	2028	0.13	0.23	0.31	0.18	0.33	0.45
Recreation	2043	0.05	0.09	0.12	0.07	0.13	0.18
Trend	2033	0.08	0.15	0.20	0.12	0.23	0.33
Upper Oldman Catchment 11.02							
Disturbance	2016	0.06	0.11	0.15	0.09	0.15	0.21
Fibre	2028	0.07	0.14	0.18	0.11	0.21	0.29
Protection	2047	0.04	0.07	0.10	0.06	0.10	0.14
Recreation	2023	0.01	0.01	0.02	0.01	0.02	0.02
Trend	2043	0.03	0.05	0.07	0.04	0.08	0.12

The absolute increases in probable peak flows, Table 7, need to be evaluated against site–specific channel characteristics. An increase of 0.6 m^3/s (Table 7, Catchment 7.01, Fibre Scenario, 10–yr instantaneous peak) could be detrimental to resident fish. It is impossible to determine the importance of such increases without reference to the instream and downstream users of the stream and water affected. Any change greater than 10% in the magnitude of the frequently recurring flow events should result in an on–site evaluation of the probable effect.

Livingstone Basin Analysis

The Livingstone Basin Analysis indicates that under the Disturbance Scenario, peak flows of the 100–year event increase by only 2.5%. Peak flows of the 10–year event, which is often of special concern to fisheries managers because of its potential for altering stream morphology and associated fish habitat, change only 1.83% under the Disturbance Scenario. Approximately 16% of the basin is burned in the Disturbance Scenario.

The Trend, where approximately 17% of the basin is harvested, changes peak flows by approximately the same modest amount. The results of both alternatives are considered acceptable from the standpoint of hydrologic impacts. The Fibre Scenario harvests almost half of the watershed over several years. Modelling indicates that peak flows of the 100–year event change by 7.54%, while those of the 10–year event increase by 5.62%. While this is within the 15% threshold, it is cause for some concern and additional investigations would be warranted if such a magnitude of harvesting was seriously considered.

Oldman Basin Analysis

The modelling of the entire Oldman Basin indicates the Trend Scenario may increase yields by as much as 3.9% for the 2–year event and 3.8% for the 100–year event. All other increases are below these figures. Impacts are therefore not considered to be significant. The Fibre Scenario increase is greater with peak flows changing by over 5% for all events. The peak flow response is similar but somewhat lower for the Disturbance Scenario. All impacts of the scenarios modelled appear to be within acceptable limits in terms of peak flow.

The analysis indicates that, at the broad scale and intermediate scales, there is likely little need for concern about the impact of harvesting or burning activities on peak flows given current or likely rates of cutting. There may be concerns about water quality at these scales, but that issue has not been addressed. However, at the finer scale of the small basin where harvesting activities are likely to be concentrated, there are potentially much larger responses in peak flows and greater concern is justified. These changes may be of concern to fisheries managers, particularly if the stream reaches immediately downstream of the harvest zone are deemed critical.

WRENNS modelling carried out in association with R.H. Swanson

Figure 87. Peak Flow Results – Disturbance Scenario – Livingstone Sub Basin

Peak flow results with scenario Disturb_LS

Predicted Annual Peak Flow and Yield

Recurrence Interval	Without Harvest Flow m^3/s	Without Harvest Yield mm	With Harvest Flow m^3/s	With Harvest Yield mm	With Harvest Change m^3/s	With Harvest Percent Change
2 Years	36.09	8.7	36.66	8.8	0.566	1.54%
5 Years	66.49	16.0	67.65	16.3	1.157	1.71%
10 Years	93.14	22.5	94.88	22.9	1.737	1.83%
20 Years	19.74	28.9	22.23	29.5	2.489	2.04%
50 Years	66.31	40.1	70.17	41.0	3.858	2.27%
100 Years	105.44	49.5	110.73	50.8	5.296	2.51%

Watershed Area, km²: 358.5
Area Harvested, km²: 58.4
2028 Displayed Above
Peak Year 2028
Peak Flow Analysis Type: UPPER OLDMAN INSTANTANEOUS MAX
Return to Results

Figure 88. Peak Flow Results – Trend Scenario – Livingstone Sub Basin

Peak flow results with scenario Trend_LS

Predicted Annual Peak Flow and Yield

Recurrence Interval	Without Harvest Flow m^3/s	Without Harvest Yield mm	With Harvest Flow m^3/s	With Harvest Yield mm	With Harvest Change m^3/s	With Harvest Percent Change
2 Years	36.09	8.7	36.72	8.8	0.622	1.69%
5 Years	66.49	16.0	67.77	16.3	1.277	1.88%
10 Years	93.14	22.5	95.07	22.9	1.923	2.02%
20 Years	19.74	28.9	22.50	29.5	2.761	2.25%
50 Years	66.31	40.1	70.61	41.1	4.294	2.52%
100 Years	105.44	49.5	111.35	50.9	5.911	2.80%

Watershed Area, km²: 358.5
Area Harvested, km²: 68.6
2052 Displayed Above
Peak Year 2052
Peak Flow Analysis Type: UPPER OLDMAN INSTANTANEOUS MAX
Return to Results

Figure 89. Peak Flow Results – Fibre Scenario – Livingstone Sub Basin

Peak flow results with scenario Fibre_LS

Predicted Annual Peak Flow and Yield

Recurrence Interval	Without Harvest Flow m^3/s	Without Harvest Yield mm	With Harvest Flow m^3/s	With Harvest Yield mm	With Harvest Change m^3/s	With Harvest Percent Change
2 Years	36.09	8.7	37.91	9.1	1.817	4.79%
5 Years	66.49	16.0	70.20	16.9	3.703	5.28%
10 Years	93.14	22.5	98.69	23.8	5.548	5.62%
20 Years	19.74	28.9	27.66	30.8	7.927	6.21%
50 Years	66.31	40.1	78.56	43.0	12.246	6.86%
100 Years	105.44	49.5	122.20	53.6	16.765	7.54%

Watershed Area, km²: 358.5
Area Harvested, km²: 189.2
2043 Displayed Above
Peak Year 2043
Peak Flow Analysis Type: UPPER OLDMAN INSTANTANEOUS MAX
Return to Results

Figure 90. Peak Flow Results – Trend Scenario – Oldman River Basin

Peak flow results with scenario Oldman_Trend

Predicted Annual Peak Flow and Yield

Recurrence Interval	Without Harvest Flow m³/s	Without Harvest Yield mm	With Harvest Flow m³/s	With Harvest Yield mm	With Harvest Change m³/s	With Harvest Percent Increase
2 Years	117.1	5.4	121.7	5.6	4.53	3.9%
5 Years	236.1	10.8	244.1	11.2	8.01	3.4%
10 Years	328.5	15.1	340.0	15.6	11.46	3.5%
20 Years	421.6	19.4	436.8	20.1	15.21	3.6%
50 Years	544.1	25.0	564.5	25.9	20.40	3.7%
100 Years	633.6	29.1	657.7	30.2	24.11	3.8%

Watershed Area, km²: 1880.7
Area Harvested, km²: 467.4
2043 Displayed Above
Peak Year 2043
Peak Flow Analysis Type: UPPER OLDMAN DAILY MAX
Return to Results

Figure 91. Peak Flow Results – Fibre Scenario – Oldman River Basin

Peak flow results with scenario Oldman_Fibre

Predicted Annual Peak Flow and Yield

Recurrence Interval	Without Harvest Flow m³/s	Without Harvest Yield mm	With Harvest Flow m³/s	With Harvest Yield mm	With Harvest Change m³/s	With Harvest Percent Increase
2 Years	117.1	5.4	124.1	5.7	6.95	5.9%
5 Years	236.1	10.8	248.4	11.4	12.31	5.2%
10 Years	328.5	15.1	346.1	15.9	17.60	5.4%
20 Years	421.6	19.4	445.0	20.4	23.34	5.5%
50 Years	544.1	25.0	575.3	26.4	31.27	5.7%
100 Years	633.6	29.1	670.6	30.8	36.95	5.8%

Watershed Area, km²: 1880.7
Area Harvested, km²: 883.9
2048 Displayed Above
Peak Year 2048
Peak Flow Analysis Type: UPPER OLDMAN DAILY MAX
Return to Results

Figure 93. Hydrograph – Trend

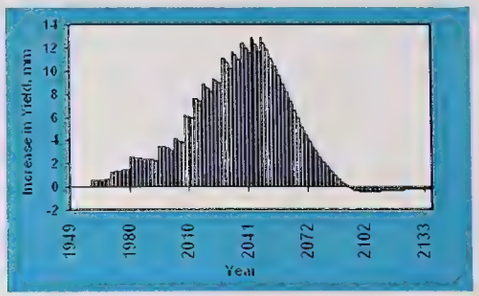


Figure 94. Hydrograph – Fibre

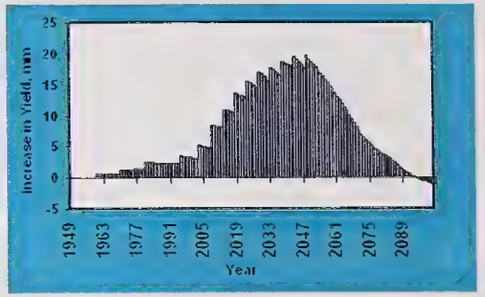


Figure 95. Hydrograph – Disturbance

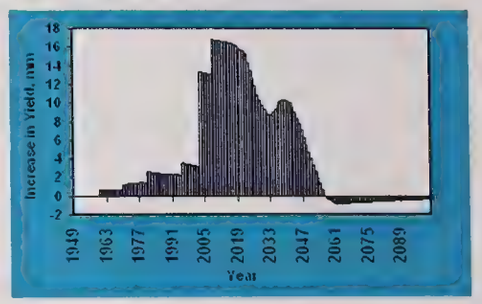


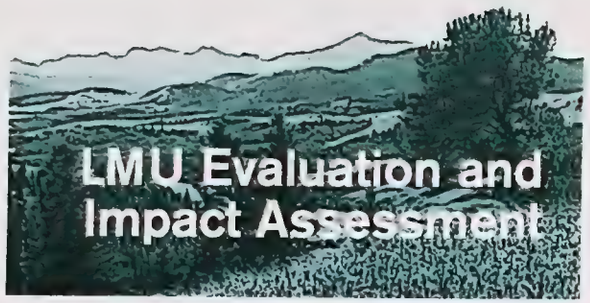
Figure 92. Peak Flow Results – Disturbance Scenario – Oldman River Basin

Peak flow results with scenario Oldman_Disturb

Predicted Annual Peak Flow and Yield

Recurrence Interval	Without Harvest Flow m³/s	Without Harvest Yield mm	With Harvest Flow m³/s	With Harvest Yield mm	With Harvest Change m³/s	With Harvest Percent Increase
2 Years	117.1	5.4	123.3	5.7	6.15	5.3%
5 Years	236.1	10.8	247.0	11.3	10.93	4.6%
10 Years	328.5	15.1	344.0	15.8	15.54	4.7%
20 Years	421.6	19.4	442.1	20.3	20.49	4.9%
50 Years	544.1	25.0	571.4	26.2	27.30	5.0%
100 Years	633.6	29.1	665.8	30.6	32.15	5.1%

Watershed Area, km²: 1880.7
Area Harvested, km²: 556.1
2008 Displayed Above
Peak Year 2008
Peak Flow Analysis Type: UPPER OLDMAN DAILY MAX
Return to Results



LMU Evaluation and Impact Assessment

4.1.9. LANDSCAPE MANAGEMENT UNIT EVALUATION AND IMPACT ASSESSMENT

While regional scale analysis of landscape characteristics and potential impacts is valuable, analysis at the scale of landscapes or landscape management units (LMUs) is also required. Impacts that appear acceptable or seem to be within the range of natural variability at the regional scale may be unacceptable at the landscape scale. Individual landscapes have differing characteristics and responses to management that must be recognized.

Flows such as fires cross landscape boundaries and often result in differing vegetation, age class and disturbance patch size distributions primarily due to the variation between landscapes in topography, climate and vegetation. If the specific characteristics of individual landscapes are to be conserved, the impacts of potential interventions needs to be assessed at the landscape scale.

Previous work has examined the characteristics of both the region and its constituent landscapes in order to provide baseline comparative data for evaluating the impact of the scenarios. While that analysis was more inclusive, the following discussion of the LMU impact analysis has been restricted to ecosite phase by leading component, age class, broad vegetation class patch size and disturbance patch size. Reporting has also been limited to four LMUs: Headwater Valleys, Middle Ridges, Porcupine Hills and Saddle Mountain. These have been selected as they represent areas that are likely to undergo the greatest change and have very different physical and biological characteristics.

Age Class Distribution by Landscape

Figures 96 through 115 indicates the age class distribution in the various landscape management units under the different scenarios. The Disturbance Scenario significantly modifies the age class distribution in all of the LMUs. As is expected, there are major increases in the youngest age classes in all LMUs.

The Trend 50 Scenario maintains age class representation in the Headwater Valleys, although the distribution tends towards a younger forest. The effect of the Trend 50 on the Middle Ridges is more pronounced with several age class cohorts completely missing (60 to 110 years old). These may be areas that have not been harvested as they are outside of the net land base and have simply aged. Similar but smaller gaps in the age class profiles occur in the Porcupine Hills and Saddle Mountain. The age class graphs are becoming bimodal. This may have an impact on species that require the characteristics of those particular age classes.

The effects of the Fibre 50 Scenario are similar to those of the Trend and the age class gaps and bimodal distribution are repeated. In the Headwater Valleys, the forest is becoming much younger with major removals of older growth. The Middle Ridges become far less "spiky" in this scenario. Saddle Mountain has a greater spread of age classes.

The Preservation 50 Scenario does little to maintain the current age class distribution. The Headwater Valleys are becoming older but representation of age classes is maintained. In the Middle Ridges, the graph is tending to become flatter with a gap in immature classes. In the Porcupine Hills and Saddle Mountain, gaps in the young to immature classes are appearing. The implications of these changes are uncertain.

The Recreation Scenario has a similar effect on all landscapes. The forest simply ages since very little harvesting or disturbance is occurring. The lack of representation in the younger cohorts as time increases would be a concern to managers.

Disturbance Patch Size

Disturbance patch size (burn or harvest block) distribution changes under the various scenarios. In the Headwater Valleys and Middle Ridges, the Trend Scenario results in smaller patches than naturally developed. In the Middle Ridges, the Fibre Scenario is leading to more patches in the 50 – 250 ha size class. Saddle Mountain changes include more patches in the 10 – 50 ha class under most scenarios. Not surprisingly, the Disturbance Scenario results in the closest approximation of the current patch size distribution.

Ecosite Phase by Leading Component

Only three scenarios are illustrated although all have been calculated. Far greater detail is available and changes may be tracked by individual ecosite phase classes in addition to the analysis of the collapsed data presented here. The largest changes to ecosite phase distribution occur in the Middle Ridges under the Disturbance regime with a shift from pine to clearcut/burns. This is expected to rebound quickly however. Other large changes occur in the Porcupine Hills under the Fibre Scenario when mixedwood sites are greatly reduced due to regeneration to coniferous forests. The implications of this to biodiversity are likely to be important given the results of the avian diversity analysis that indicated the importance of aspen dominated stands.

Coniferous, Deciduous, Mixedwood, Grassland, Other (CDMGO) Patch Size

CDMGO Patch Size is an important generalized measure of landscape conditions. A comparison has been made between the Trend 50 and Fibre 50 Scenarios. In the Headwater Valleys and Middle Ridges, the Fibre 50 Scenario causes a decline in the patch size of coniferous stands. In the Porcupine Hills, the Fibre 50 Scenario significantly reduces large deciduous patches.

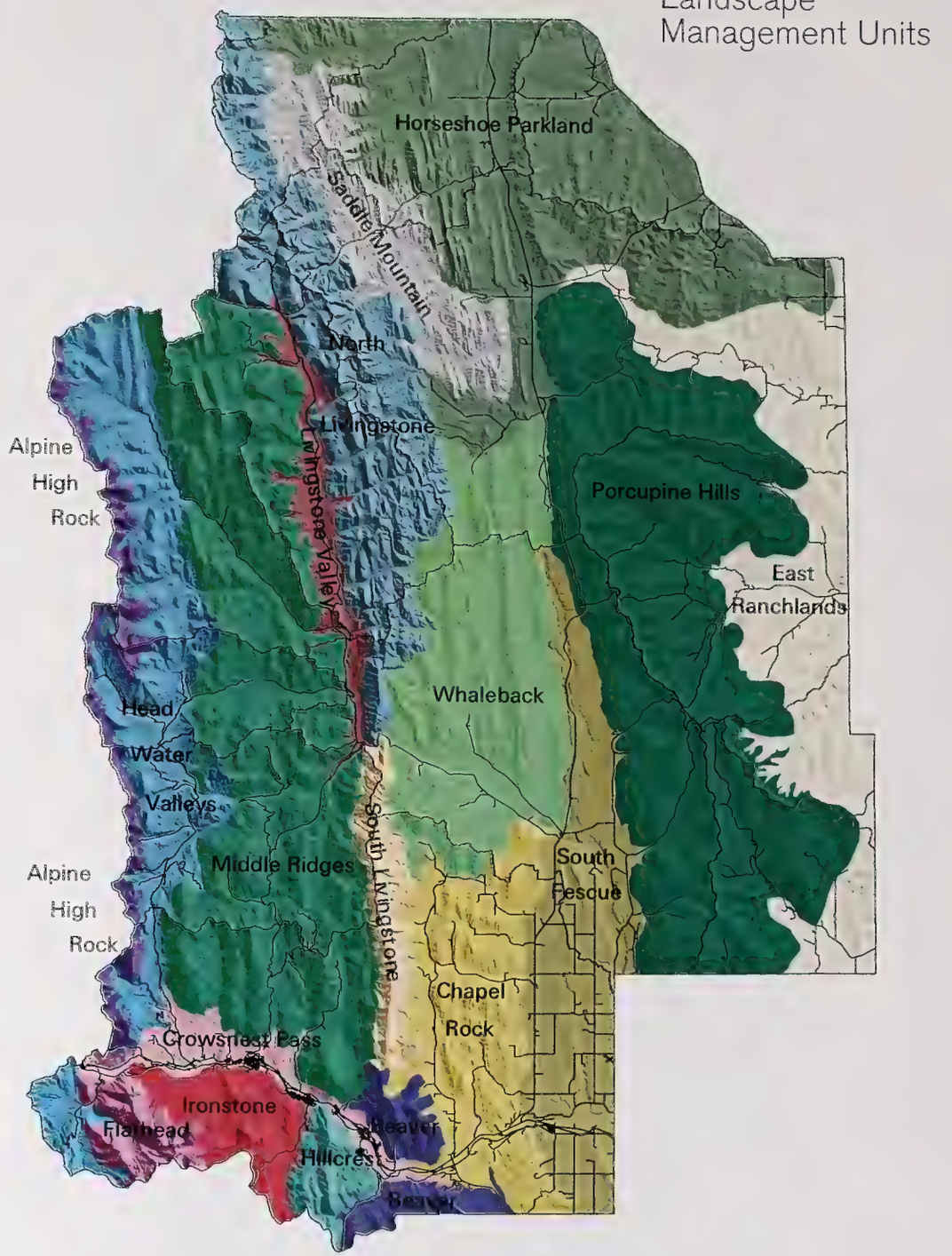


Figure 96. Age Class Distribution – Disturbance Scenario – Headwater Valleys

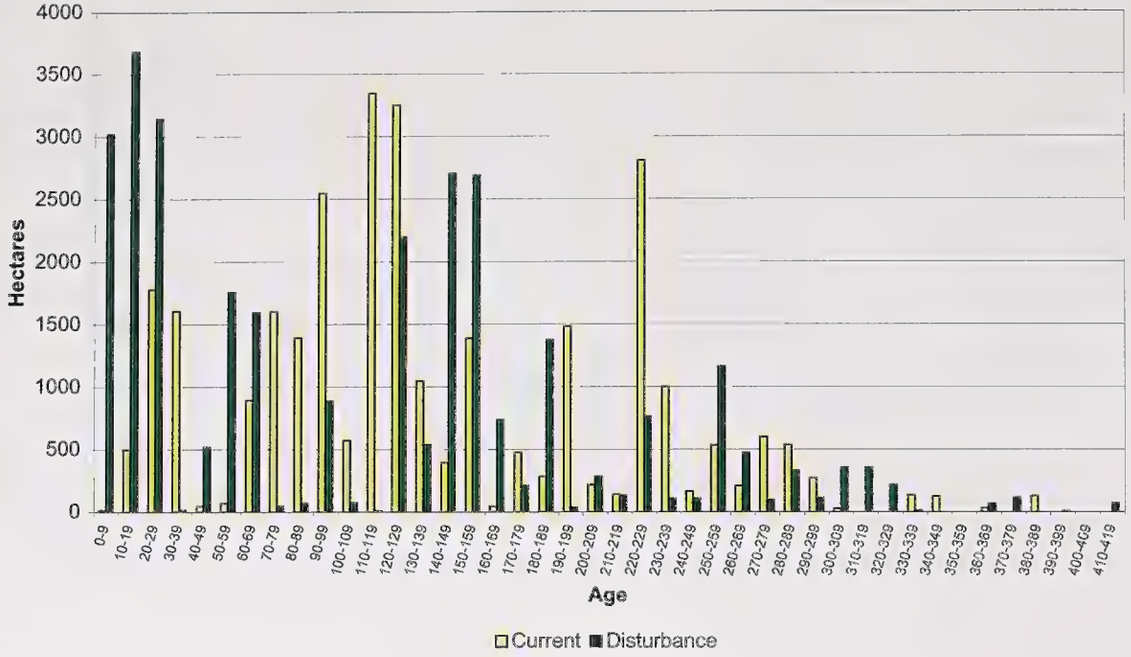


Figure 97. Age Class Distribution – Disturbance Scenario – Middle Ridges

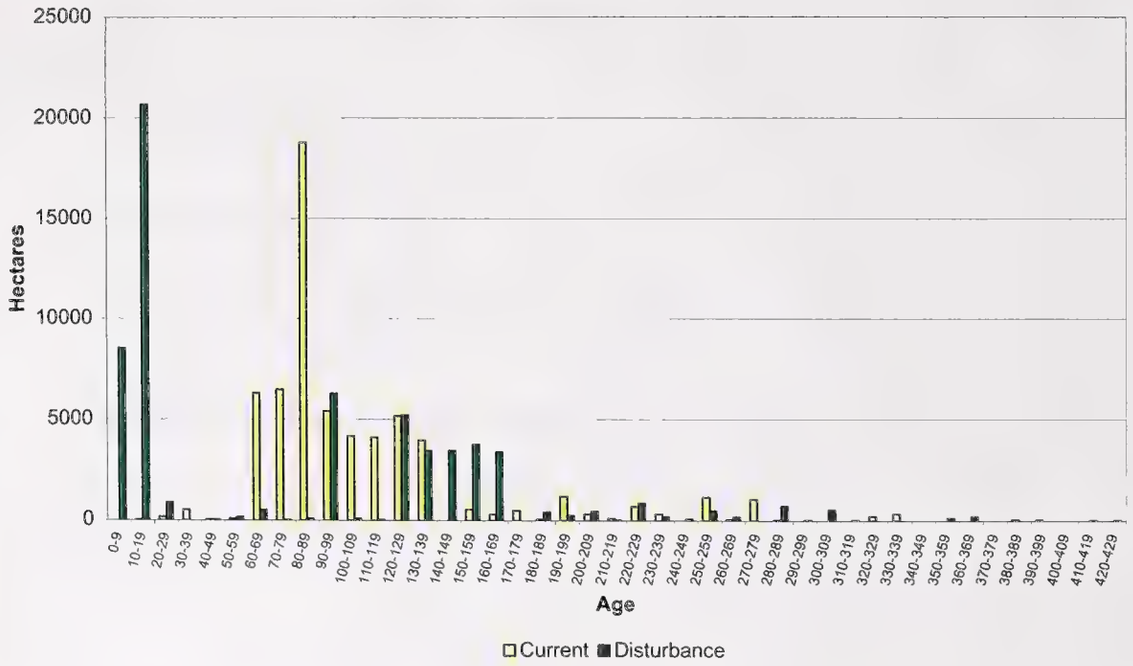


Figure 98. Age Class Distribution – Disturbance Scenario – Porcupine Hills

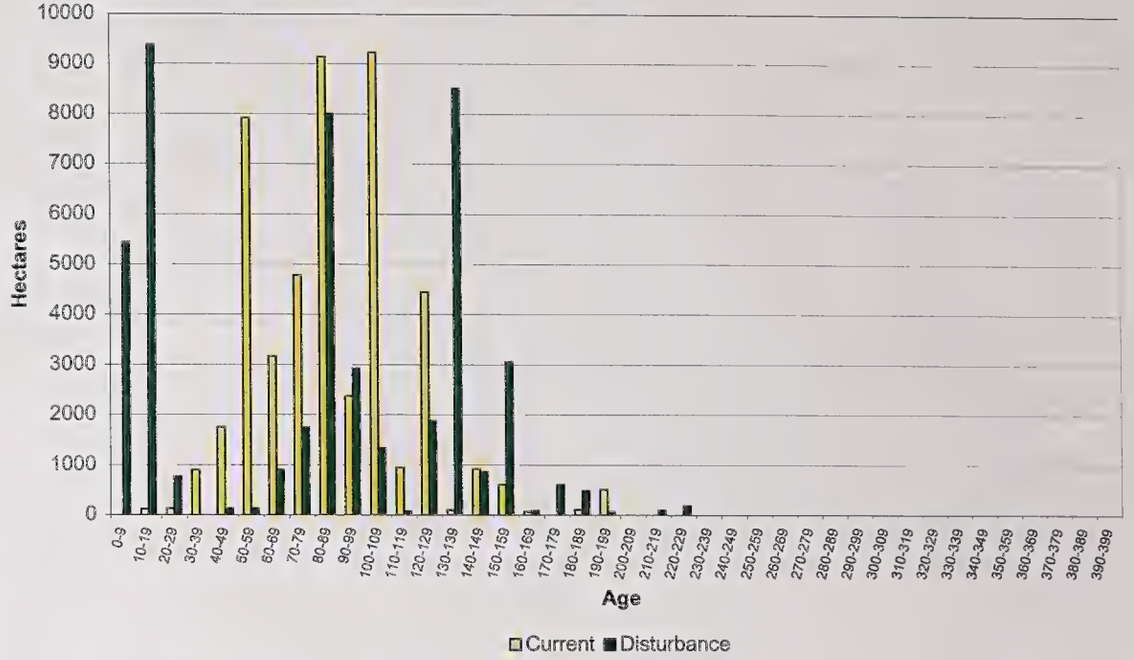


Figure 99. Age Class Distribution – Disturbance Scenario – Saddle Mountain

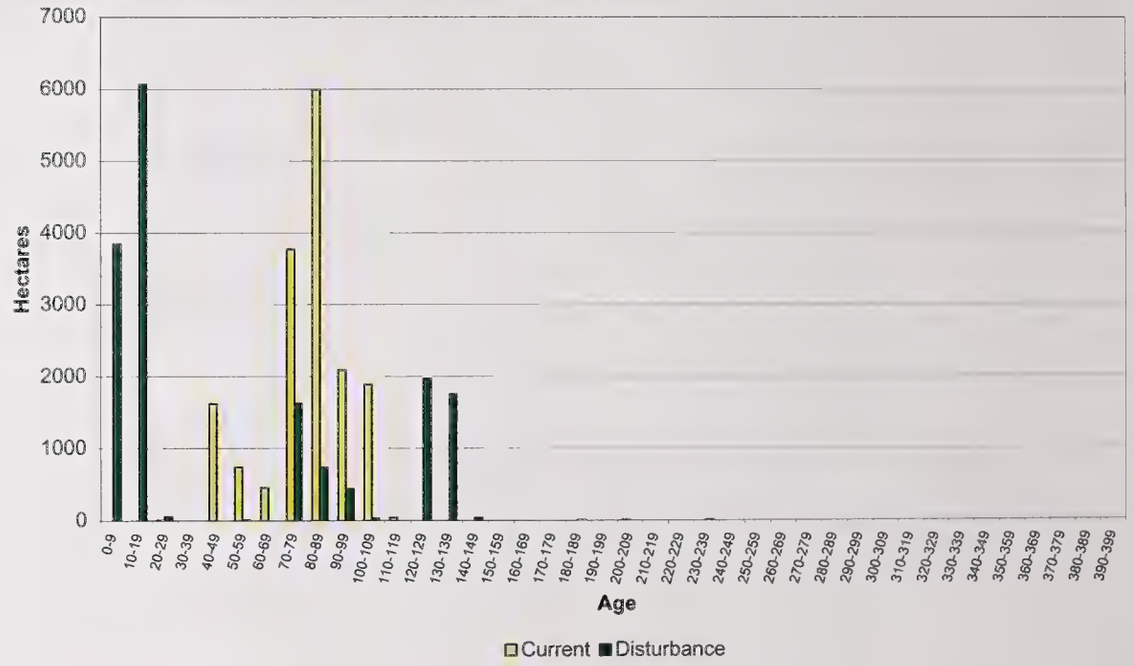


Figure 100. Age Class Distribution – Trend 50 – Headwater Valleys

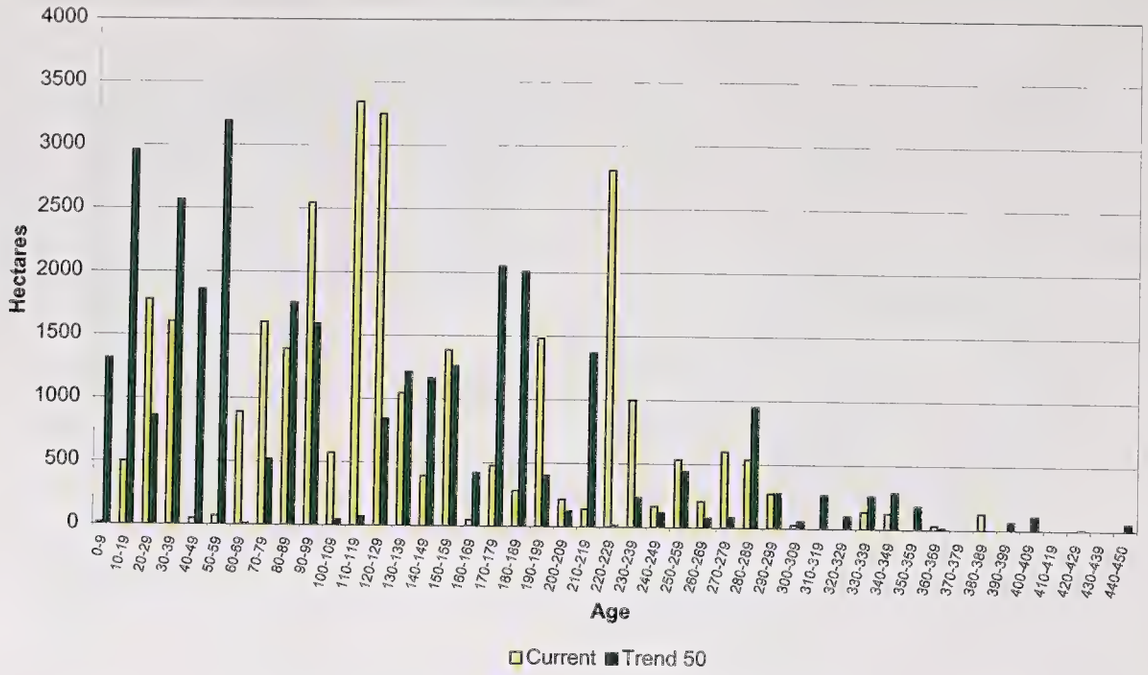


Figure 101. Age Class Distribution – Trend 50 – Middle Ridges

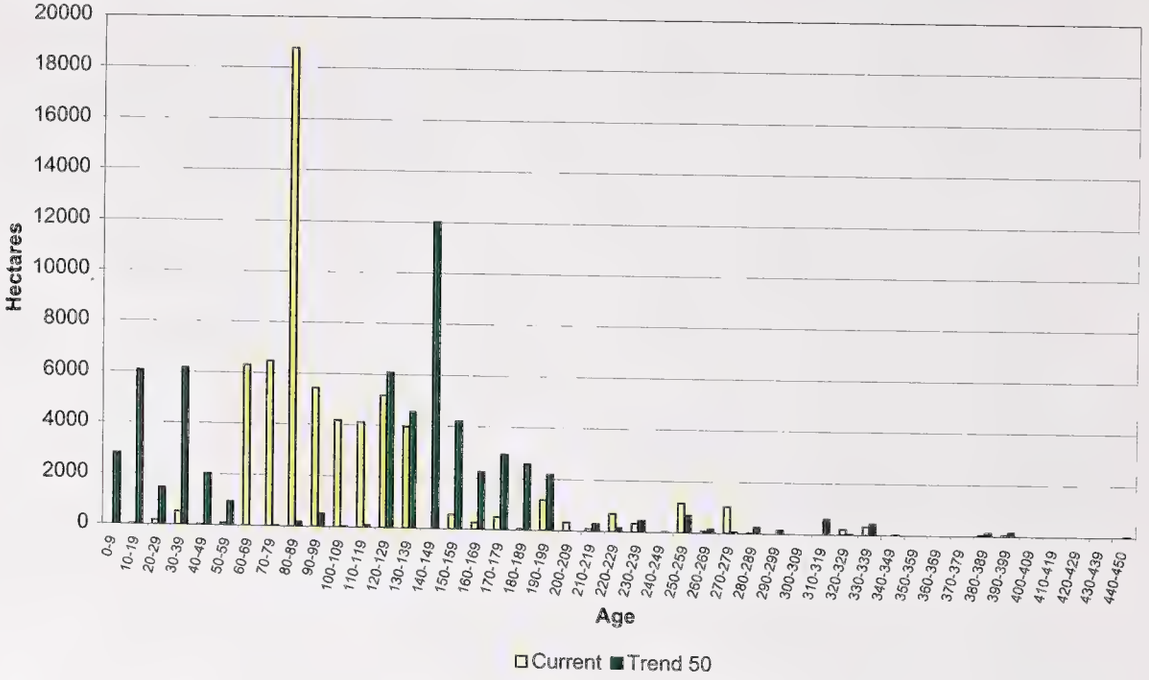


Figure 102. Age Class Distribution – Trend 50 – Porcupine Hills

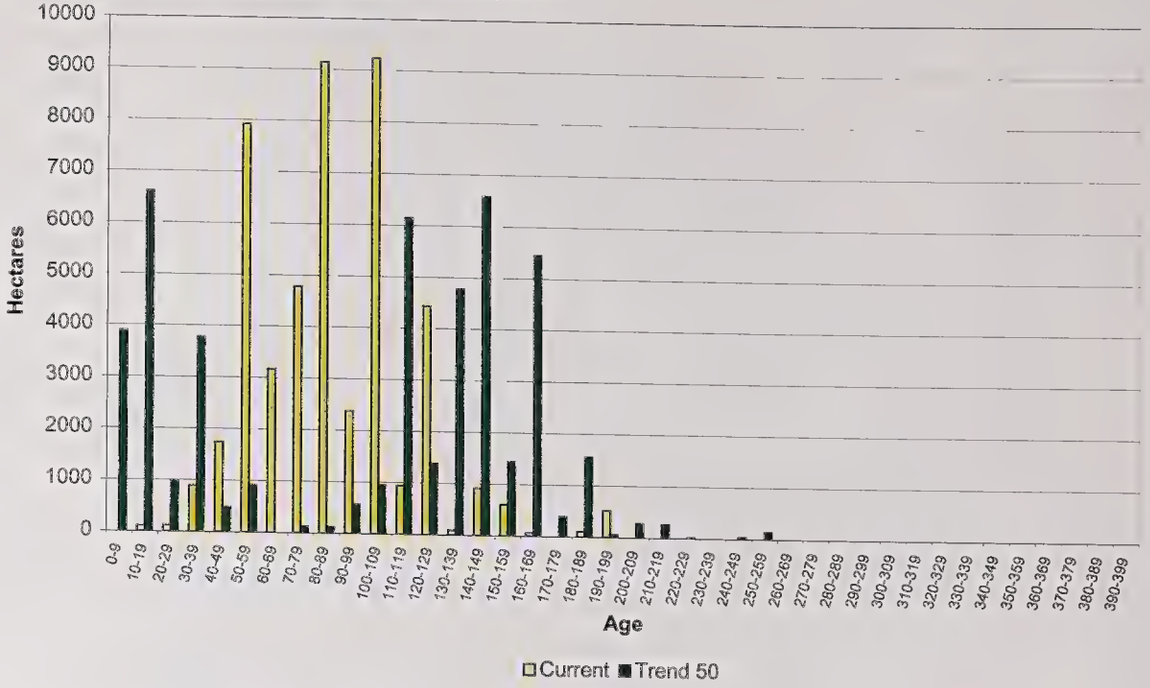


Figure 103. Age Class Distribution – Trend 50 – Saddle Mountain

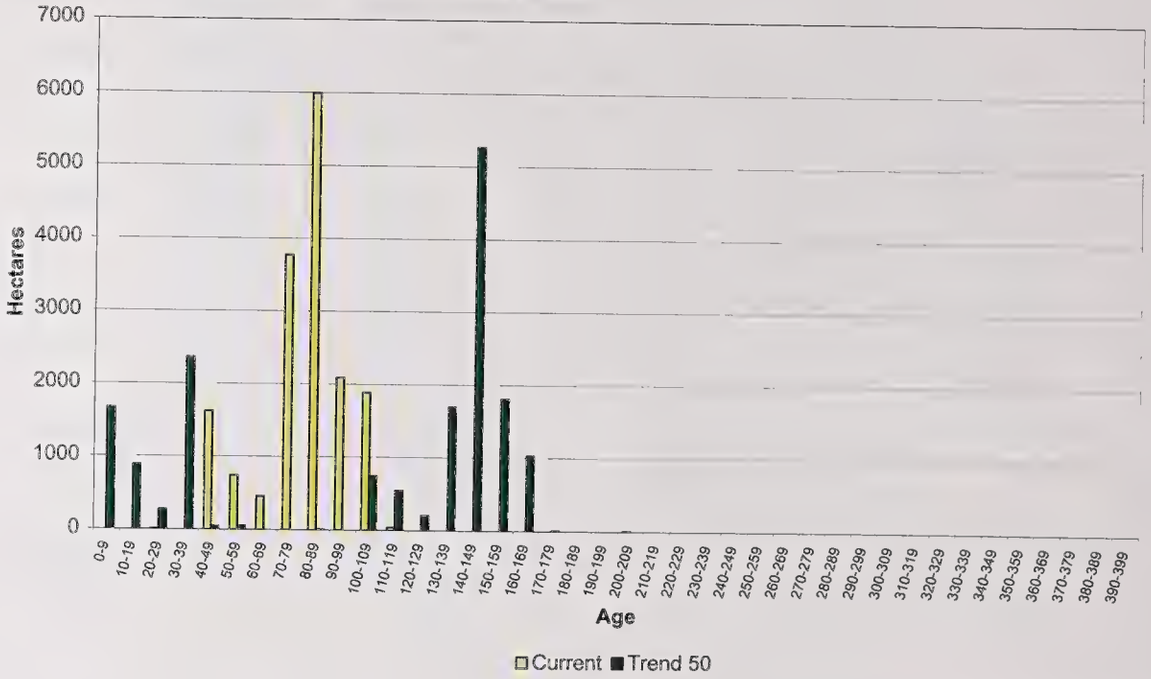


Figure 104. Age Class Distribution – Fibre 50 – Headwater Valleys

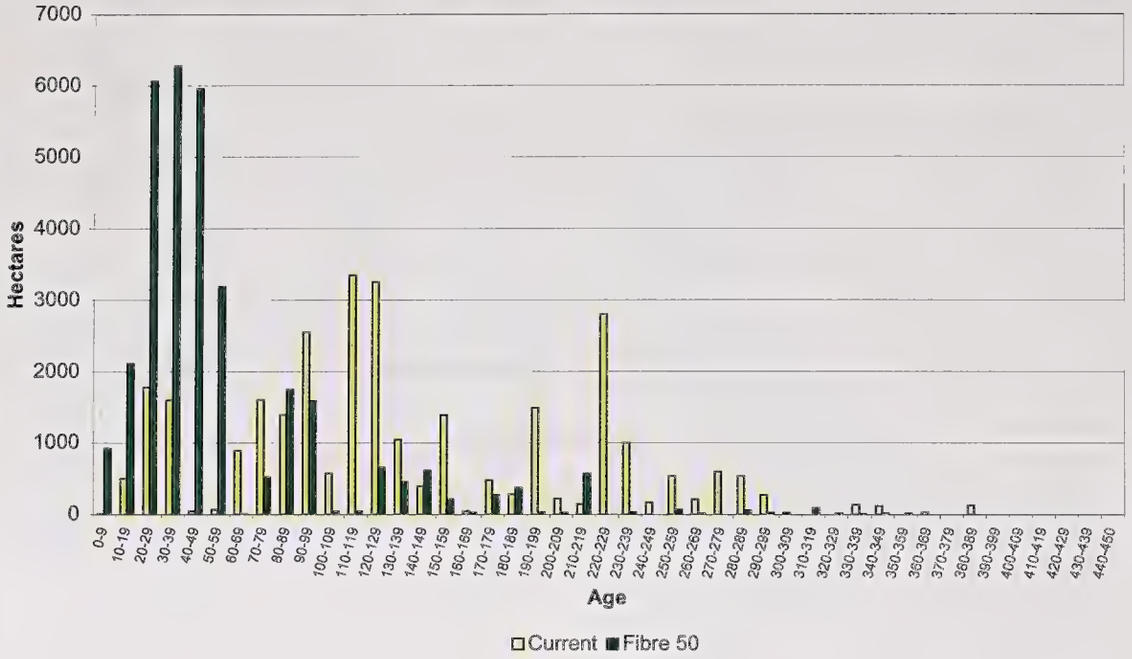


Figure 105. Age Class Distribution – Fibre 50 – Middle Ridges

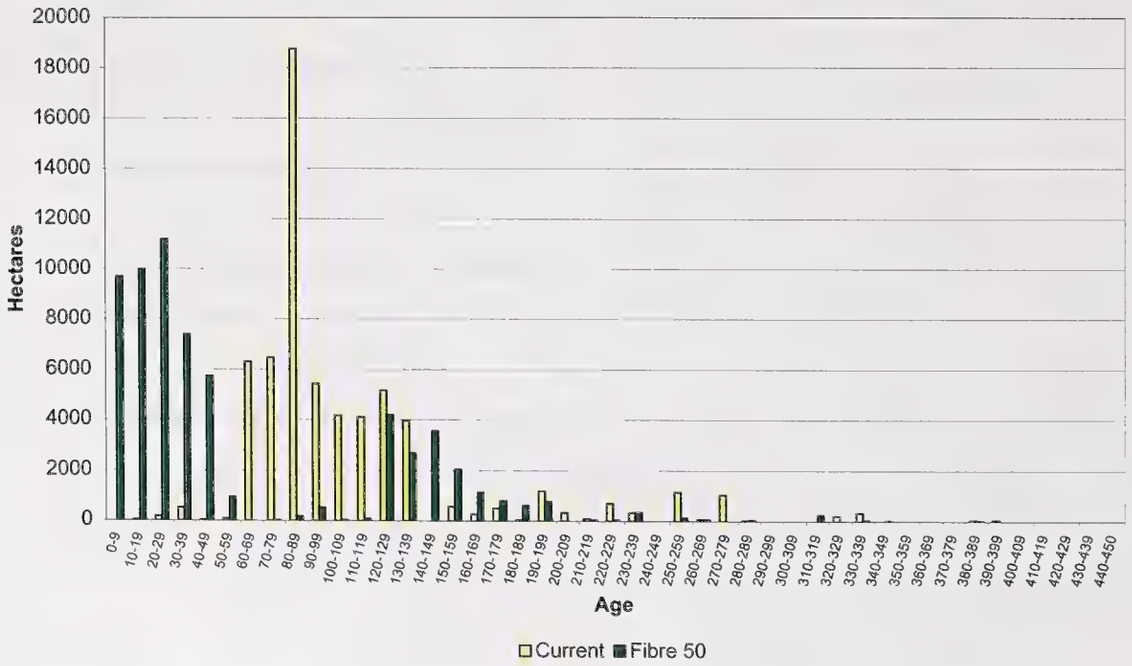


Figure 106. Age Class Distribution – Fibre 50 – Porcupine Hills

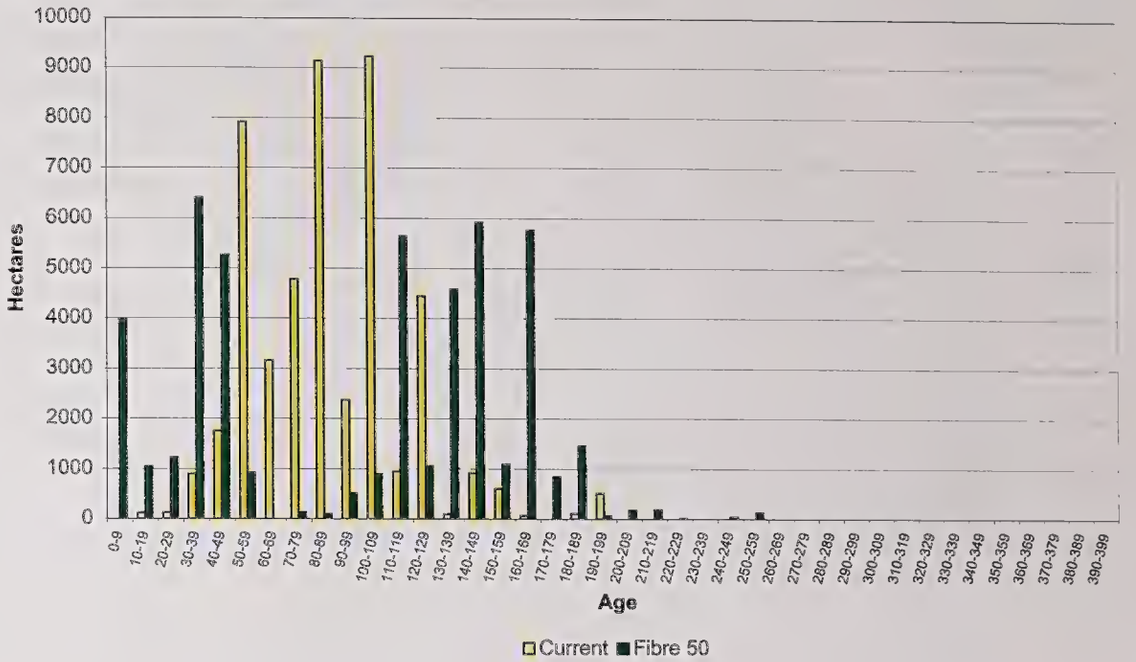


Figure 107. Age Class Distribution – Fibre 50 – Saddle Mountain

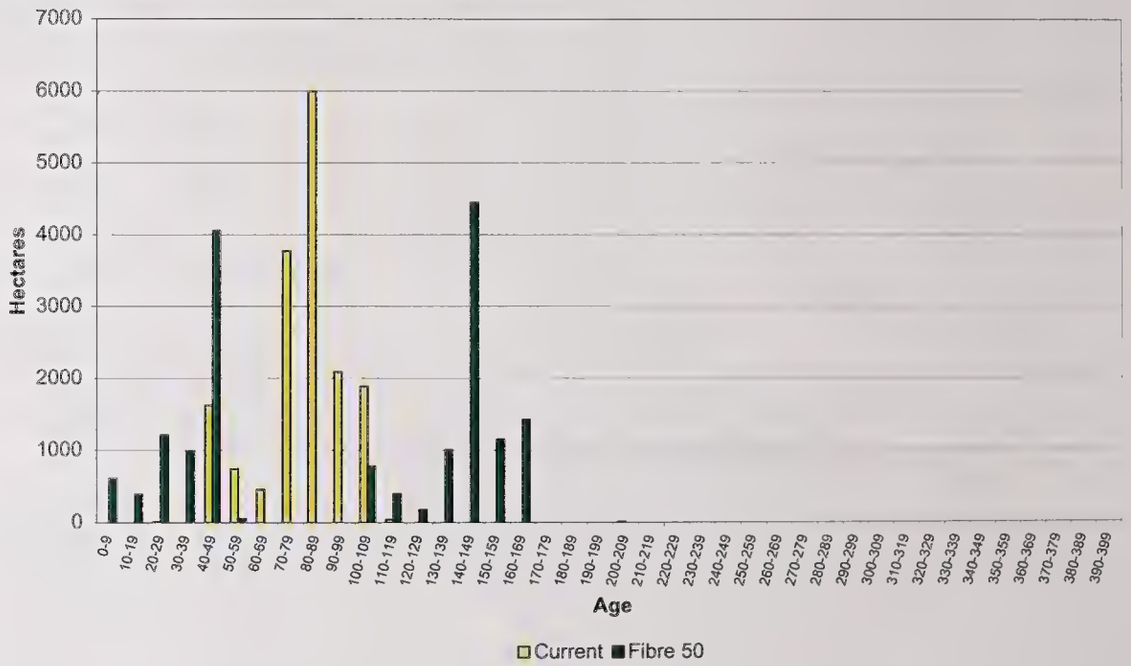


Figure 108. Age Class Distribution – Preservation 50 – Headwater Valleys

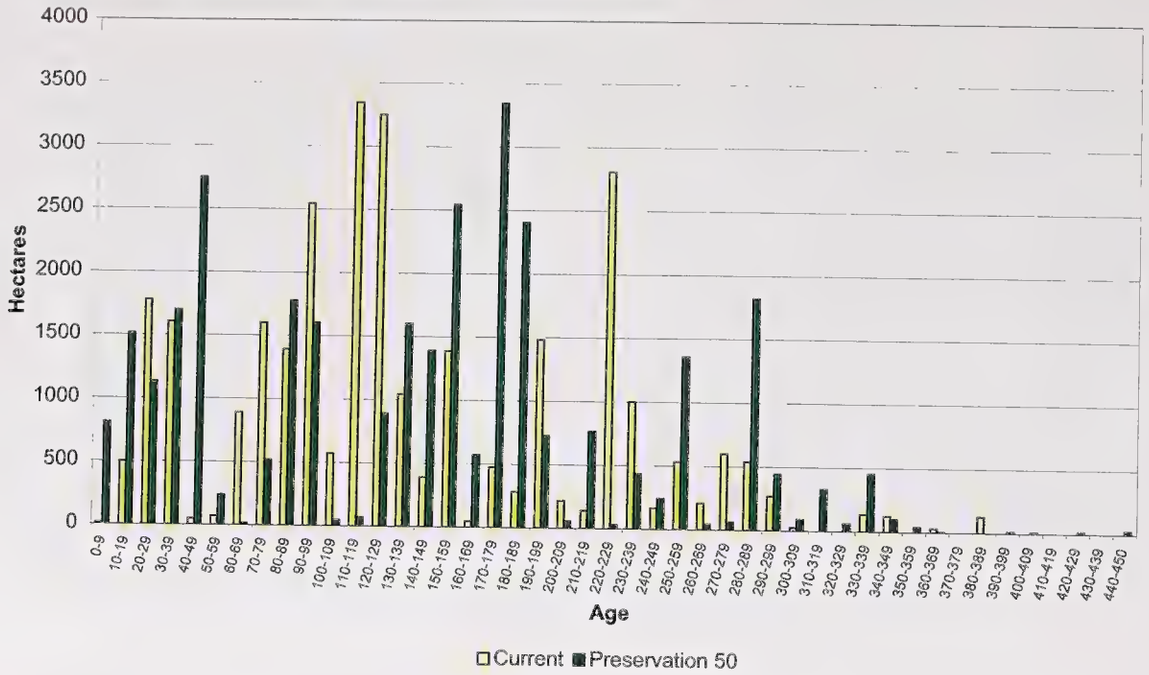


Figure 109. Age Class Distribution – Preservation 50 – Middle Ridges

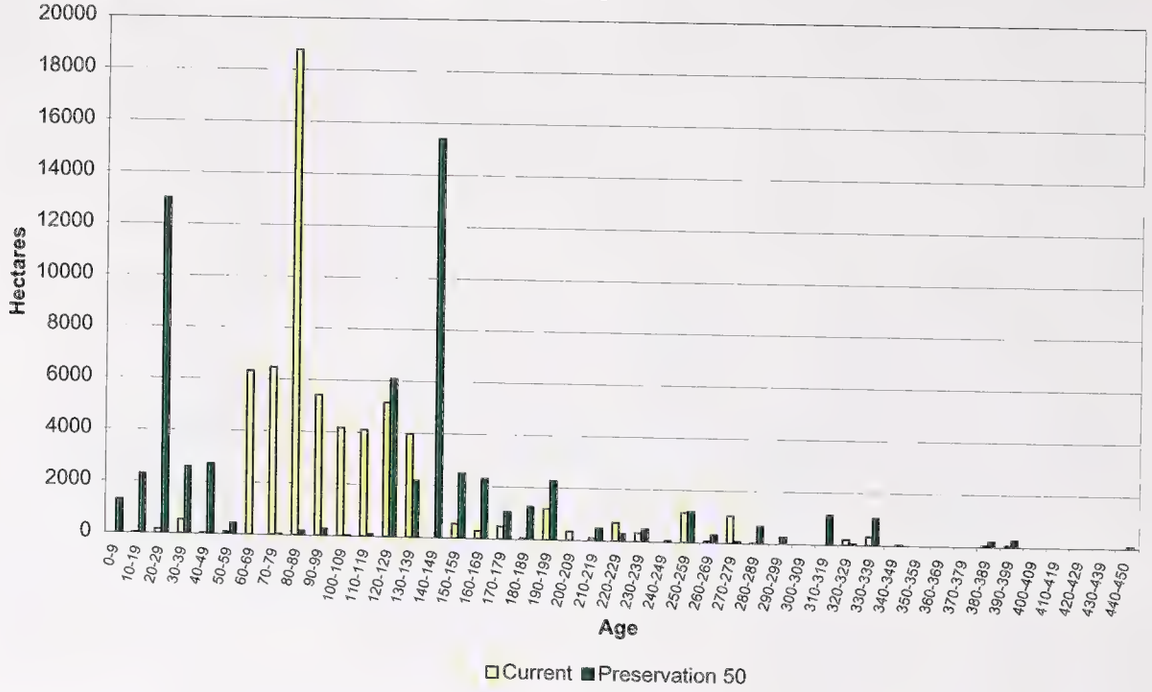


Figure 110. Age Class Distribution – Preservation 50 – Porcupine Hills

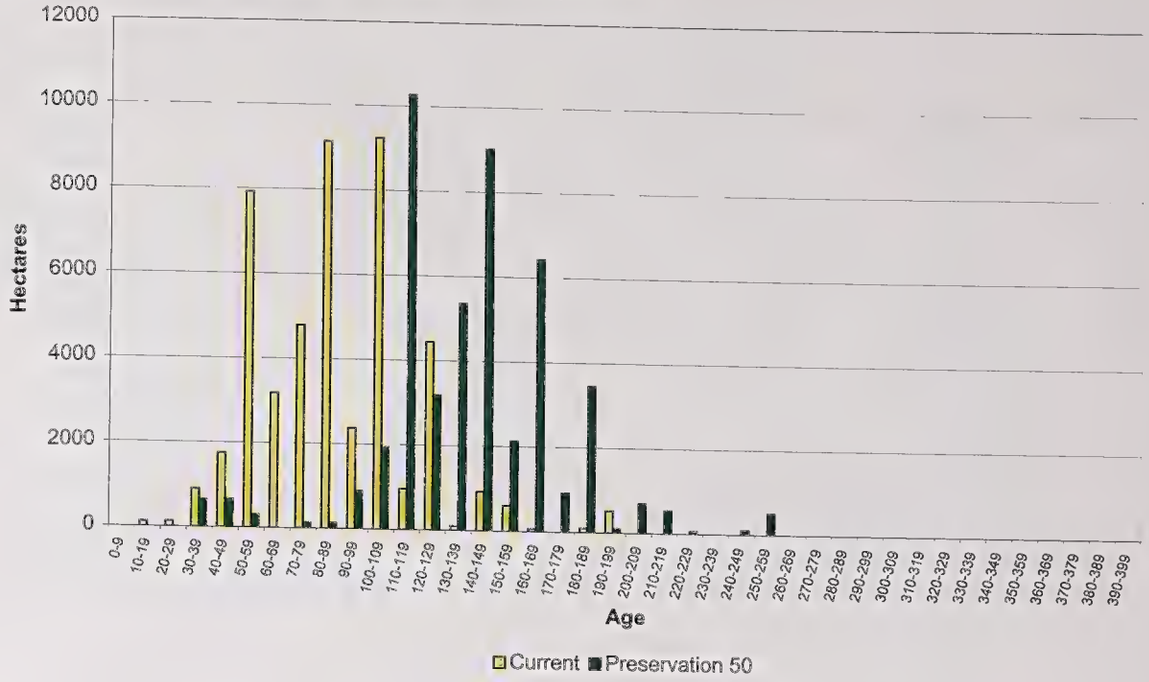


Figure 111. Age Class Distribution – Preservation 50 – Saddle Mountain

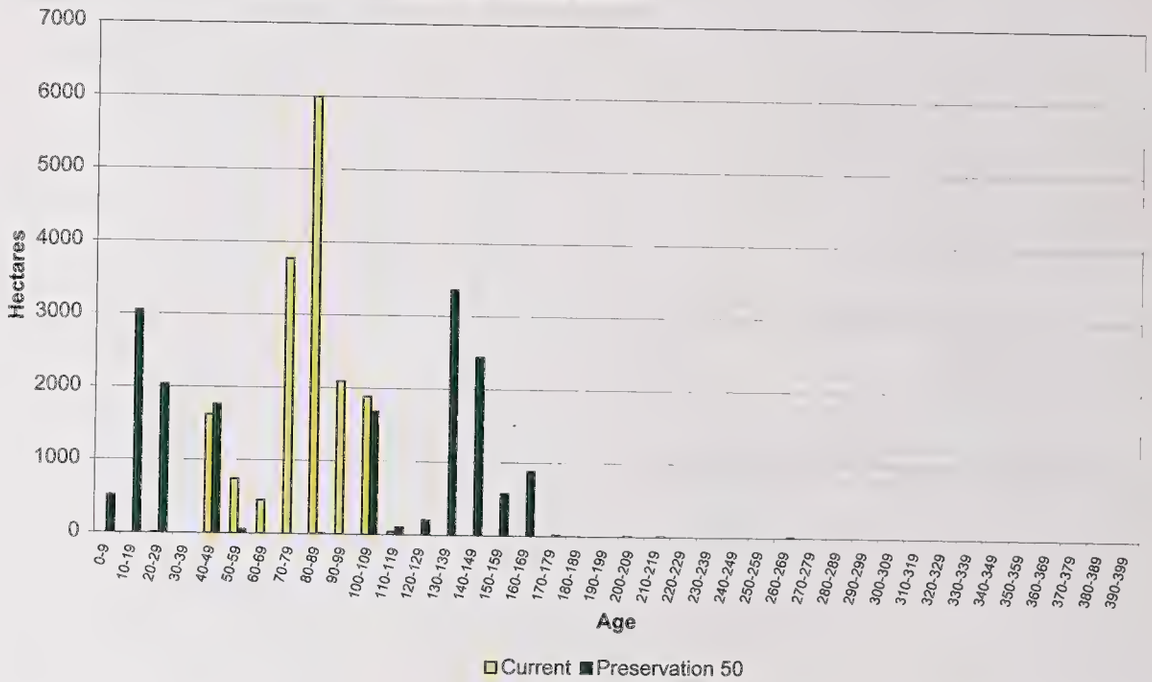


Figure 112. Age Class Distribution – Recreation 50 – Headwater Valleys

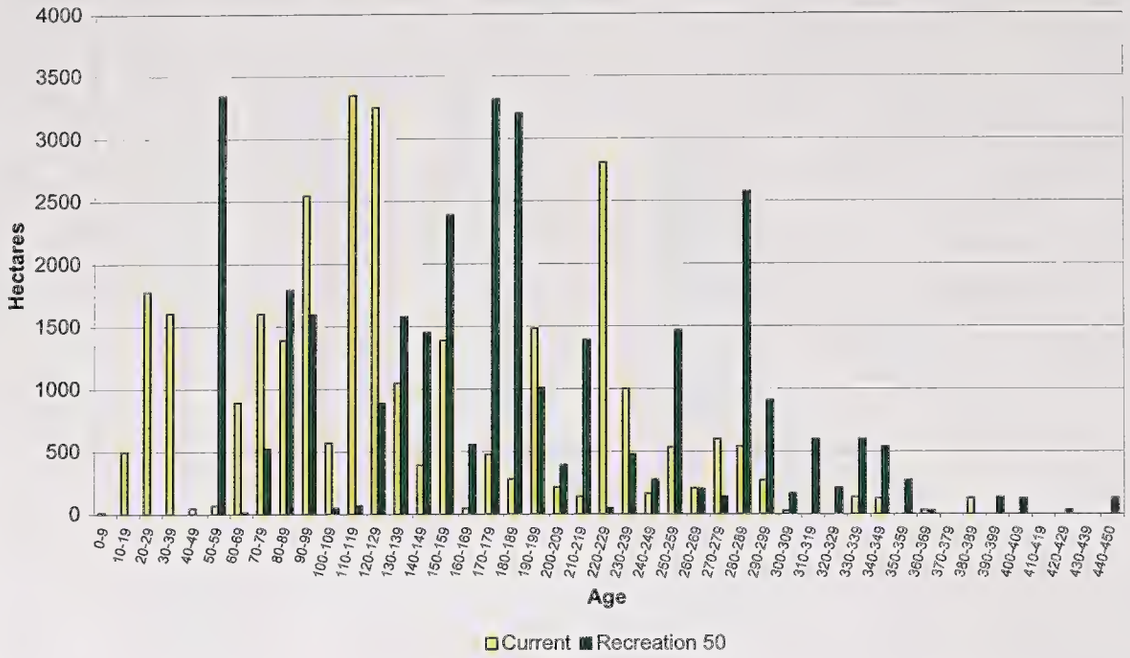


Figure 113. Age Class Distribution – Recreation 50 – Middle Ridges

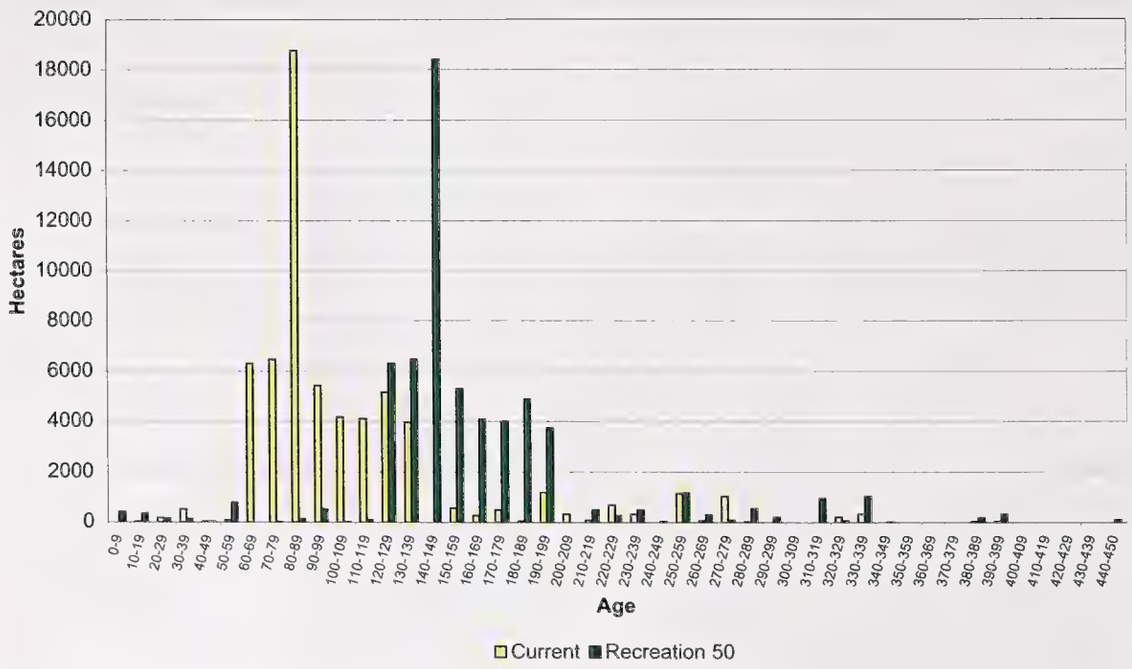


Figure 114. Age Class Distribution – Recreation 50 – Porcupine Hills

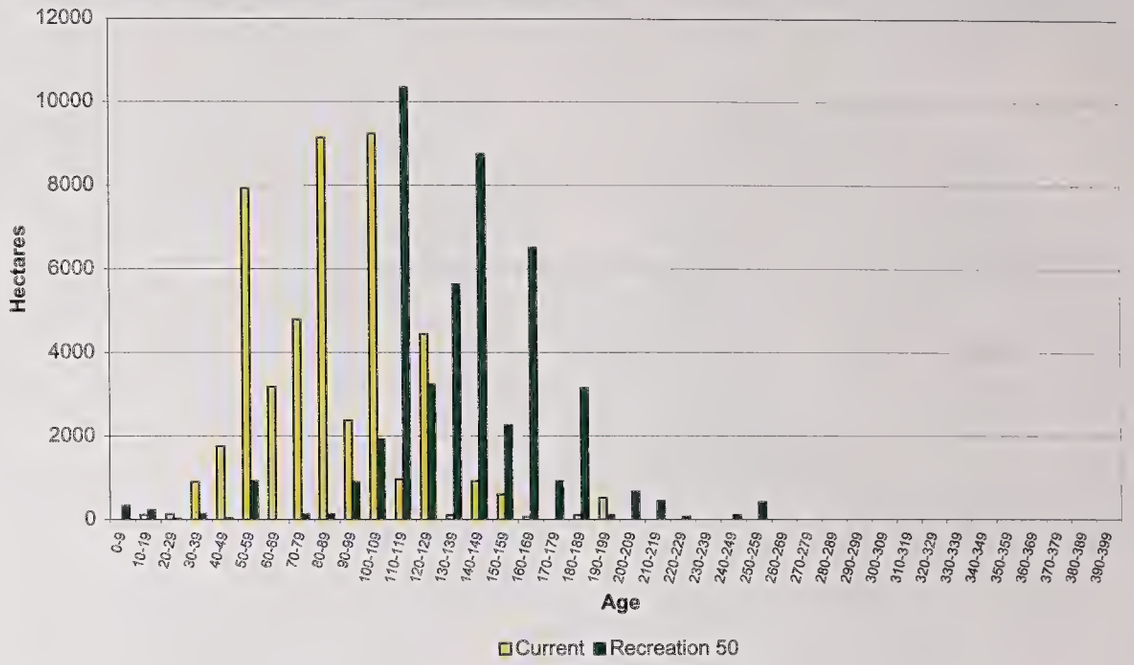


Figure 115. Age Class Distribution – Recreation 50 – Saddle Mountain

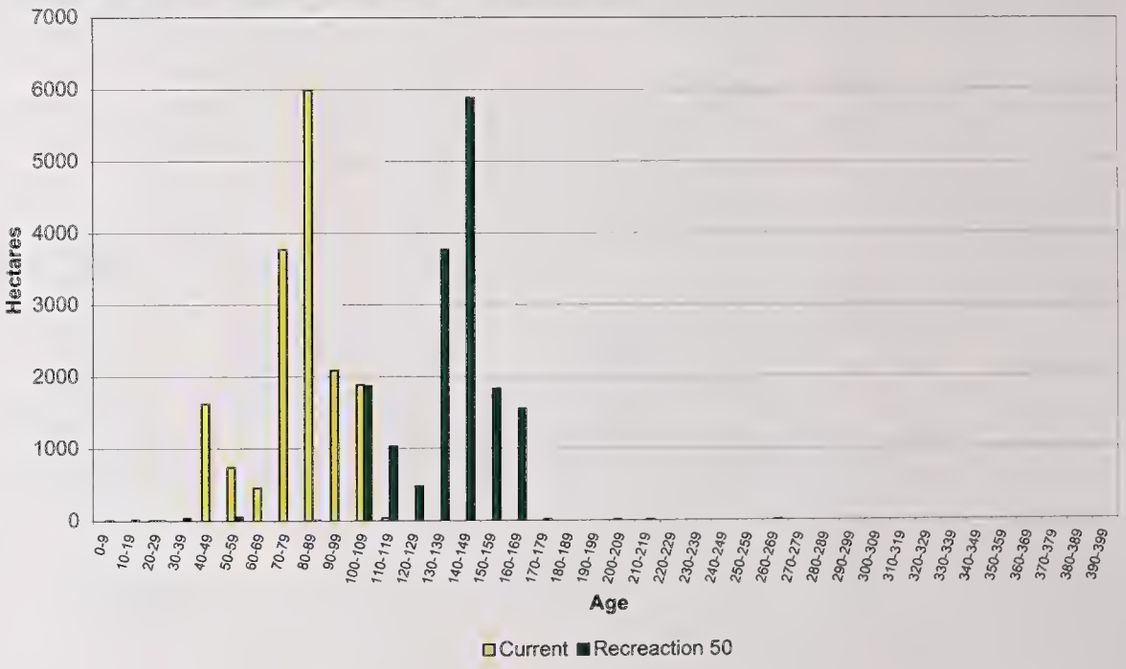


Figure 116. Disturbance Patch Size Distribution – All Scenarios – Headwater Valleys

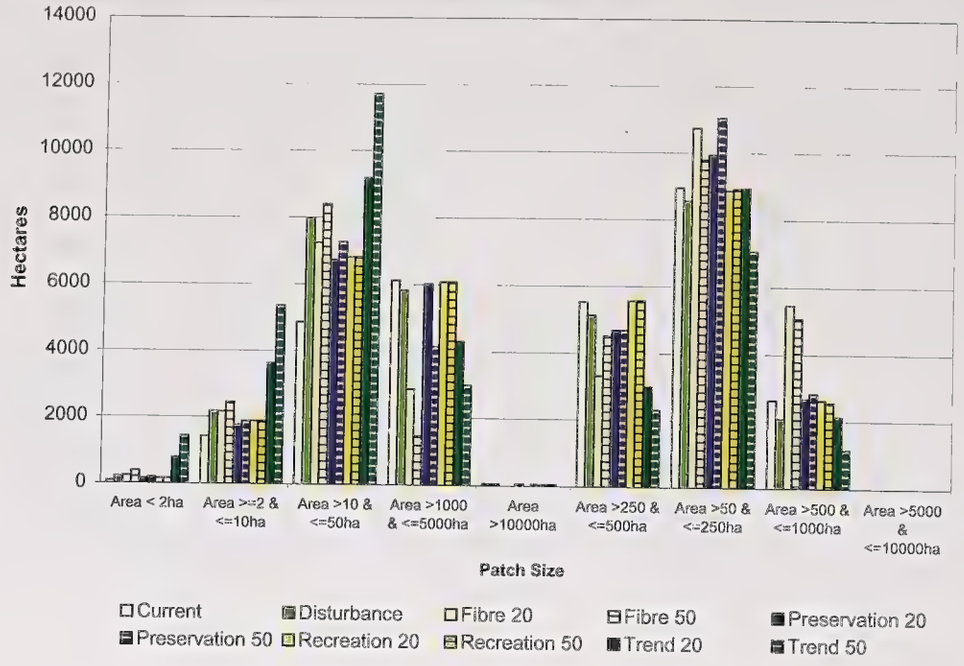


Figure 117. Disturbance Patch Size Distribution – All Scenarios – Middle Ridges

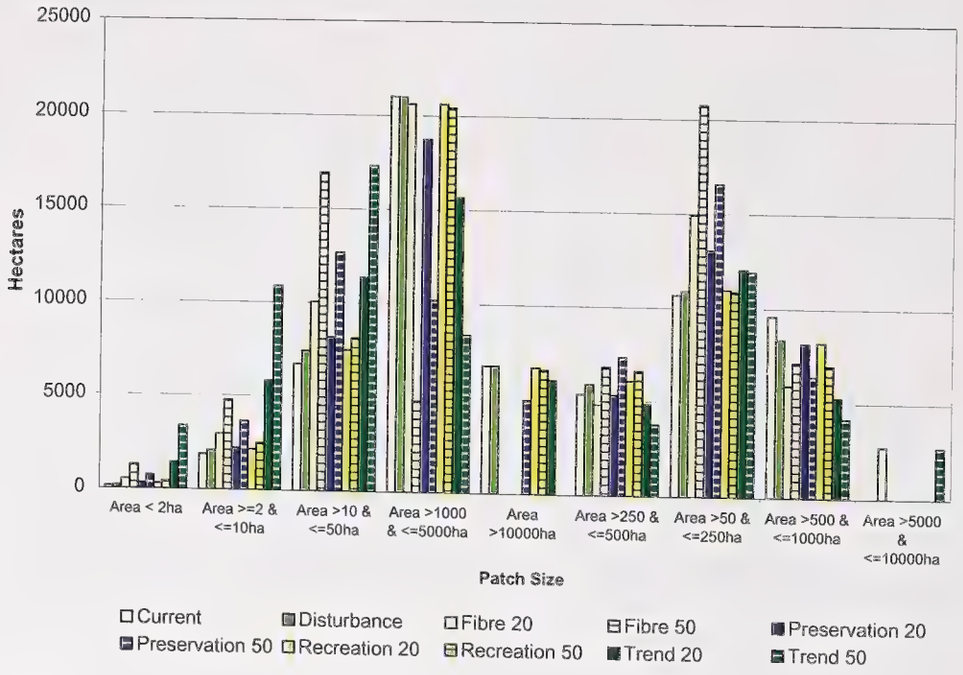


Figure 118. Disturbance Patch Size Distribution – All Scenarios – Porcupine Hills

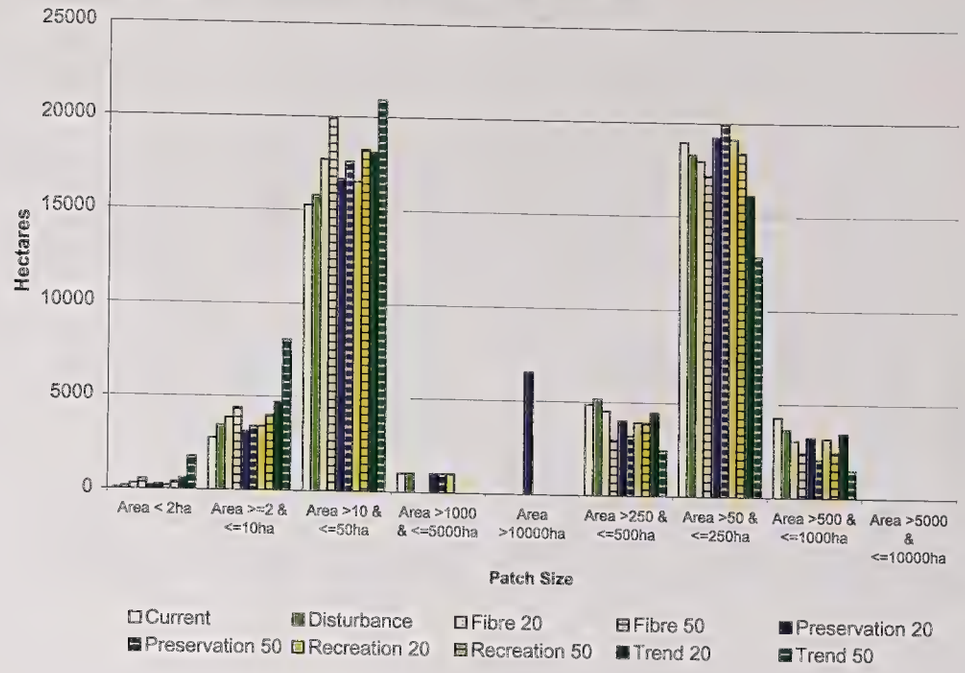
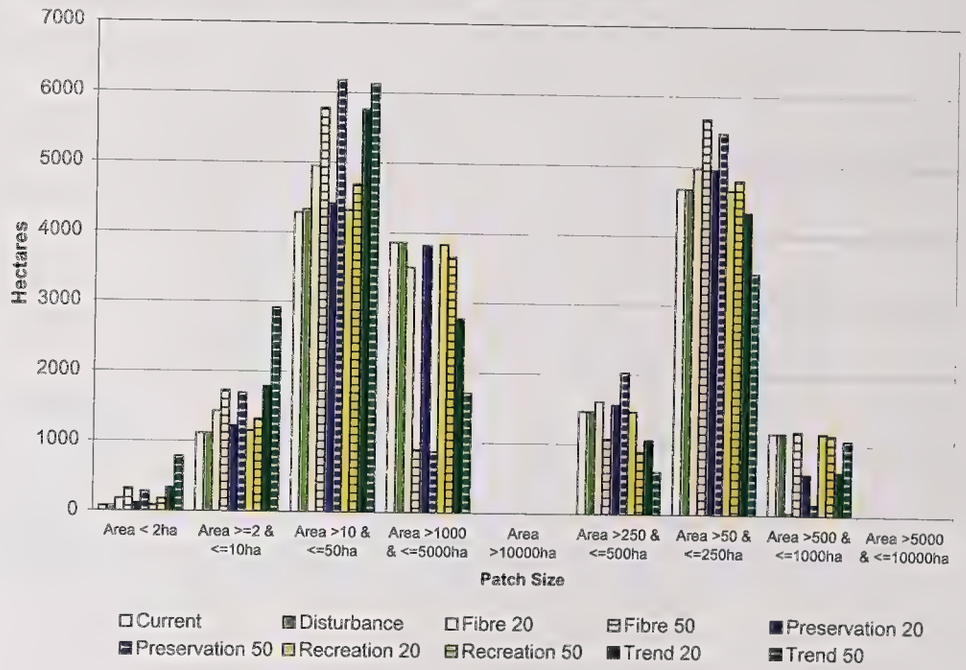


Figure 119. Disturbance Patch Size Distribution – All Scenarios – Saddle Mountain

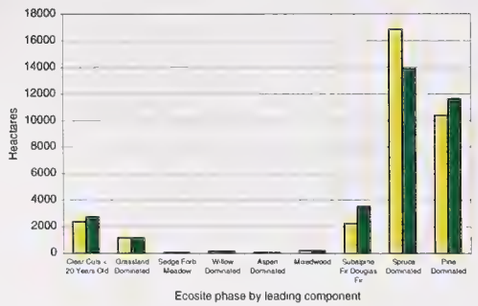


LEGEND

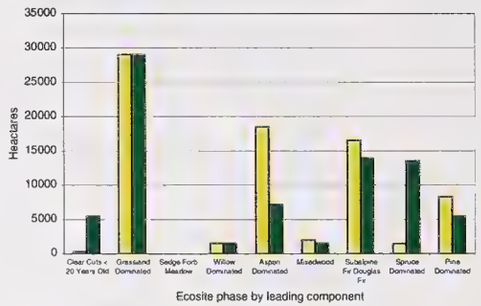
Current Future Scenario

Table 8. Ecosite Phase by Leading Component by LMU – Trend 50

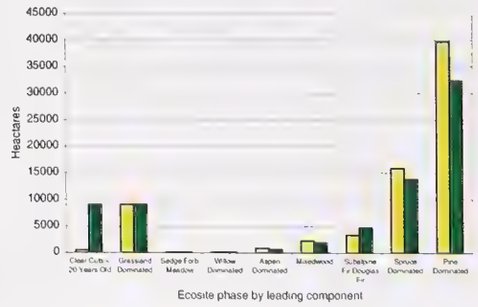
Headwater Valley



Porcupine Hills



Middle Ridges



Saddle Mountain

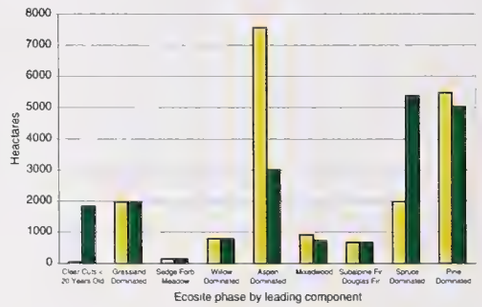
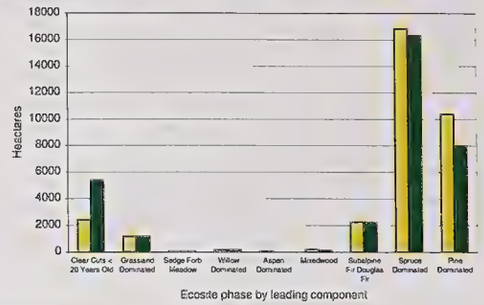
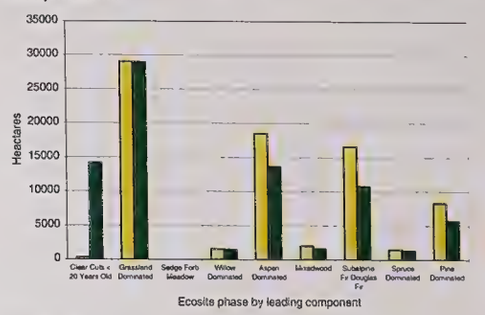


Table 9. Ecosite Phase by Leading Component by LMU – Disturbance

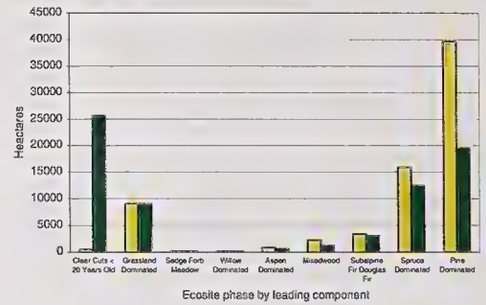
Headwater Valley



Porcupine Hills



Middle Ridges



Saddle Mountain

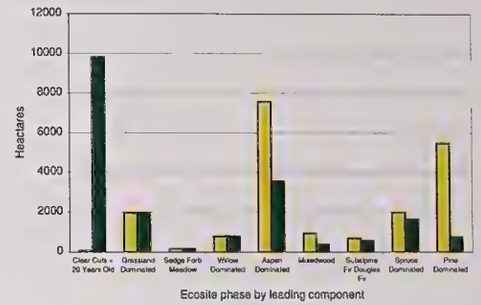
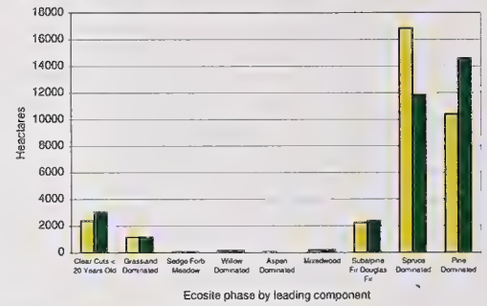
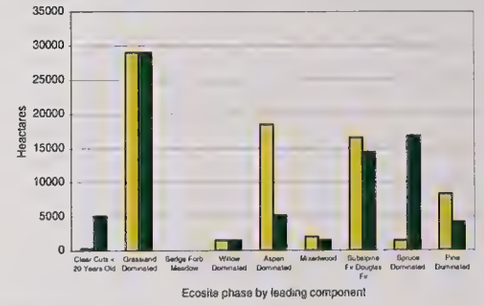


Table 10. Ecosite Phase by Leading Component by LMU – Fibre 50

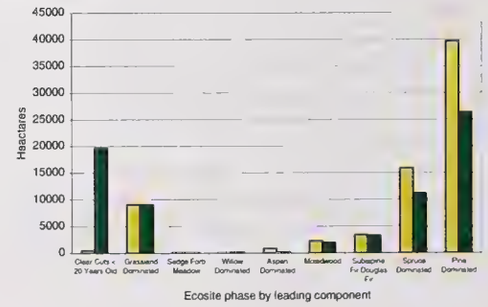
Headwater Valley



Porcupine Hills



Middle Ridges



Saddle Mountain

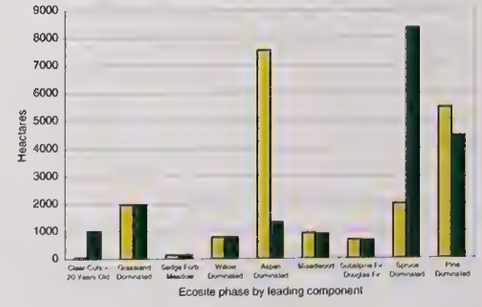
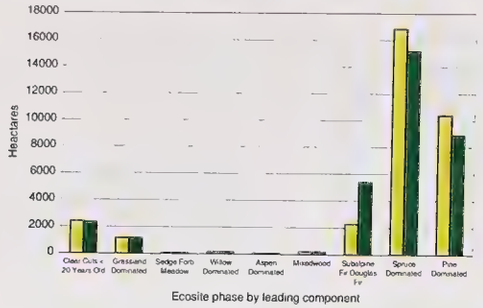
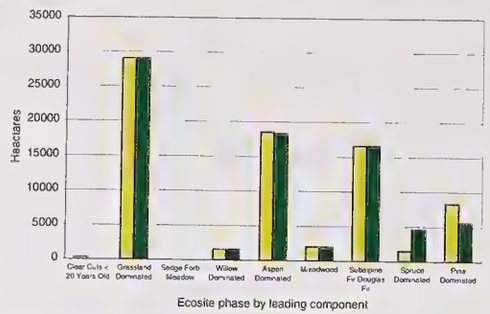


Table 11. Ecosite Phase by Leading Component by LMU – Preservation 50

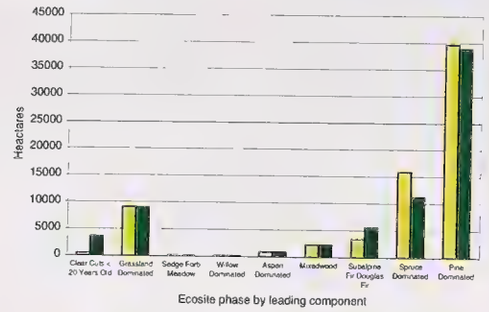
Headwater Valley



Porcupine Hills



Middle Ridges



Saddle Mountain

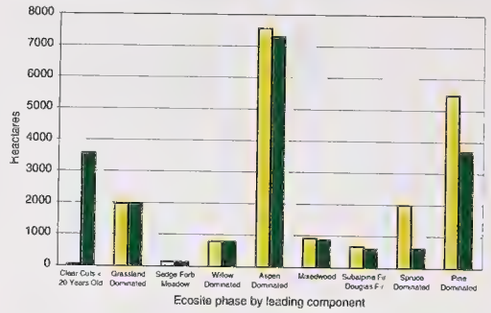
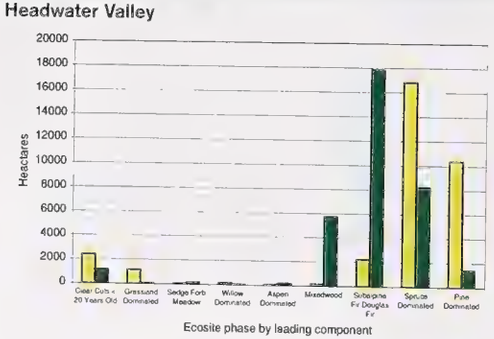
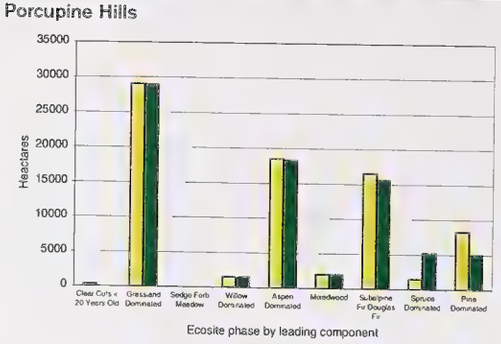


Table 12. Ecosite Phase by Leading Component by LMU – Recreation 50

Headwater Valley



Porcupine Hills



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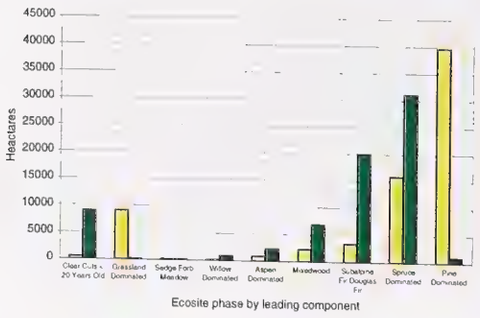

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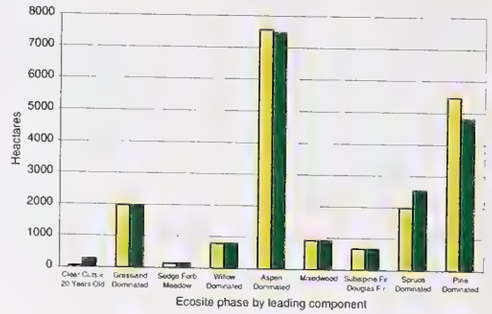


LEGEND

Current

Future Scenario

Figure 120. Coniferous, Deciduous, Mixedwood, Grassland, Other Patch Size – Trend 50 – Headwater Valleys

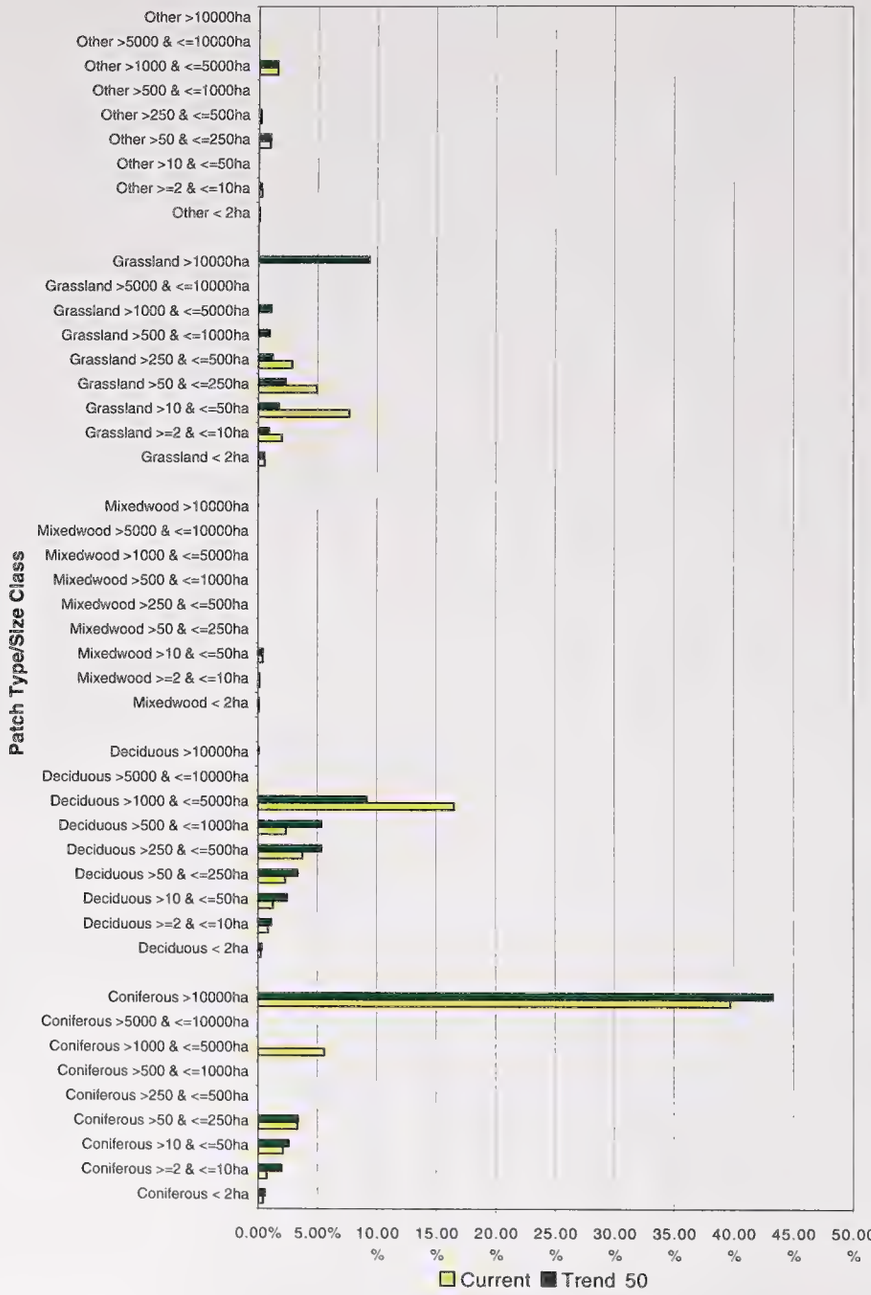


Figure 121. Coniferous, Deciduous, Mixedwood, Grassland, Other Patch Size – Fibre 50 – Headwater Valleys

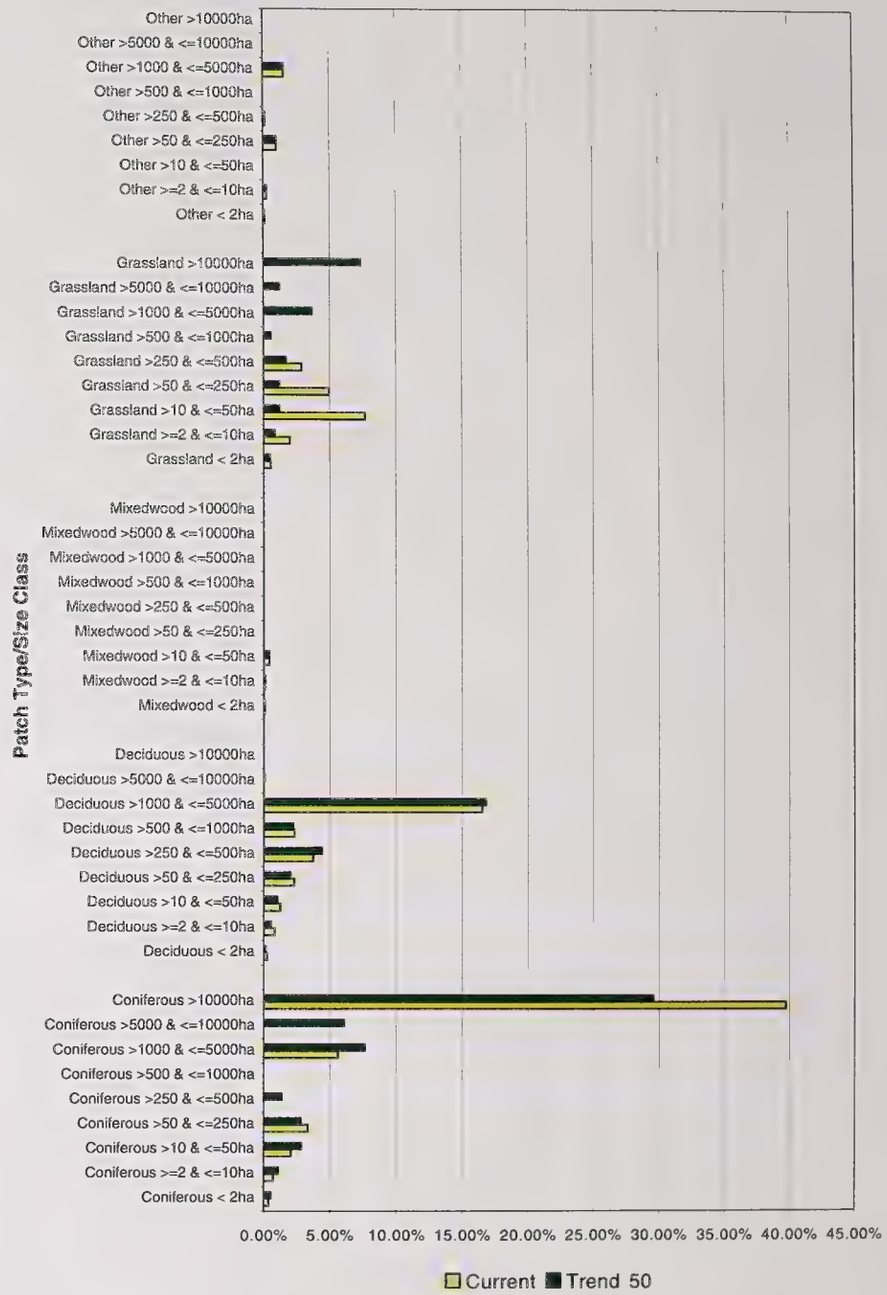


Figure 122. Coniferous, Deciduous, Mixedwood, Grassland, Other Patch Size – Trend 50 – Middle Ridges

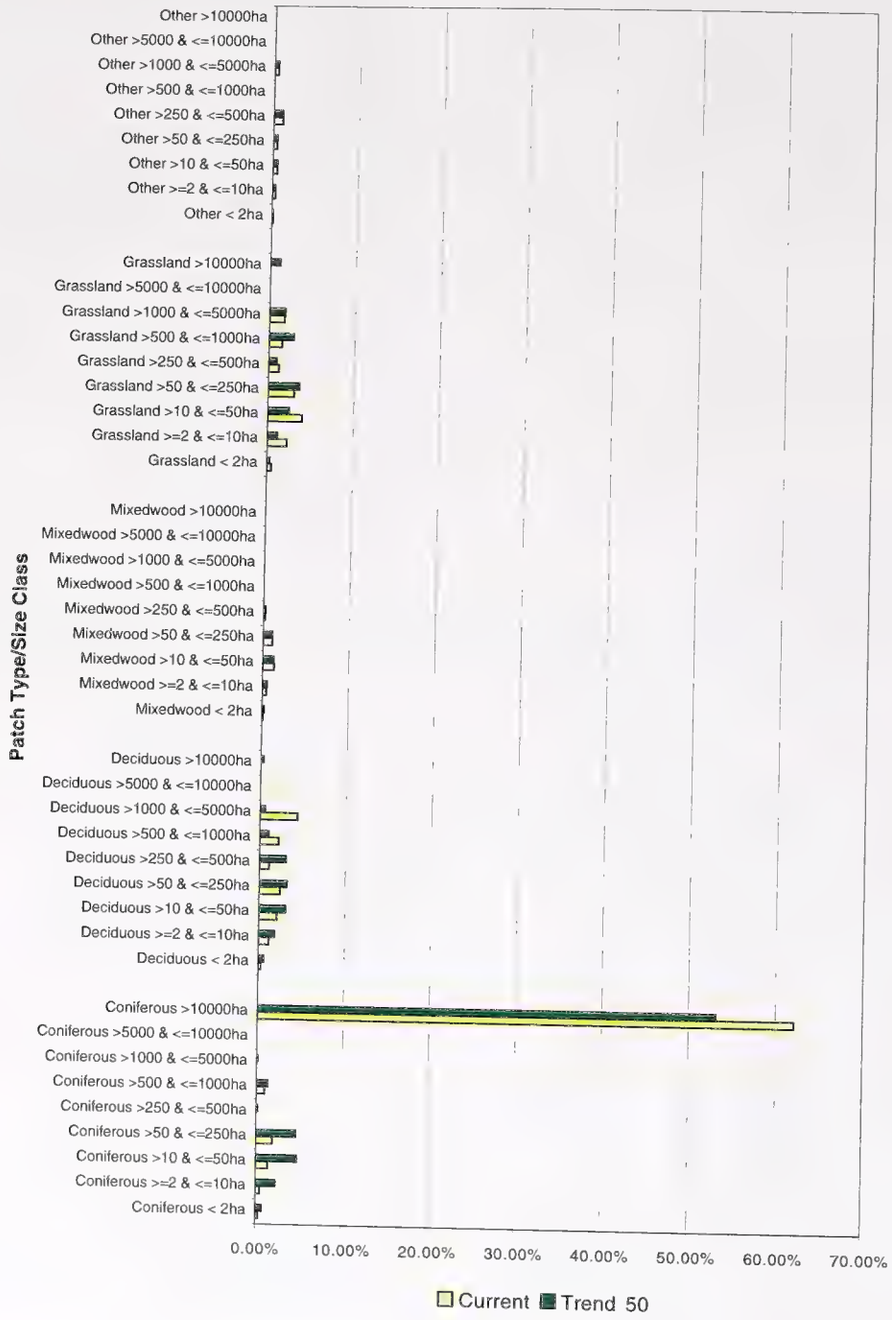


Figure 123. Coniferous, Deciduous, Mixedwood, Grassland, Other Patch Size – Fibre 50 – Middle Ridges

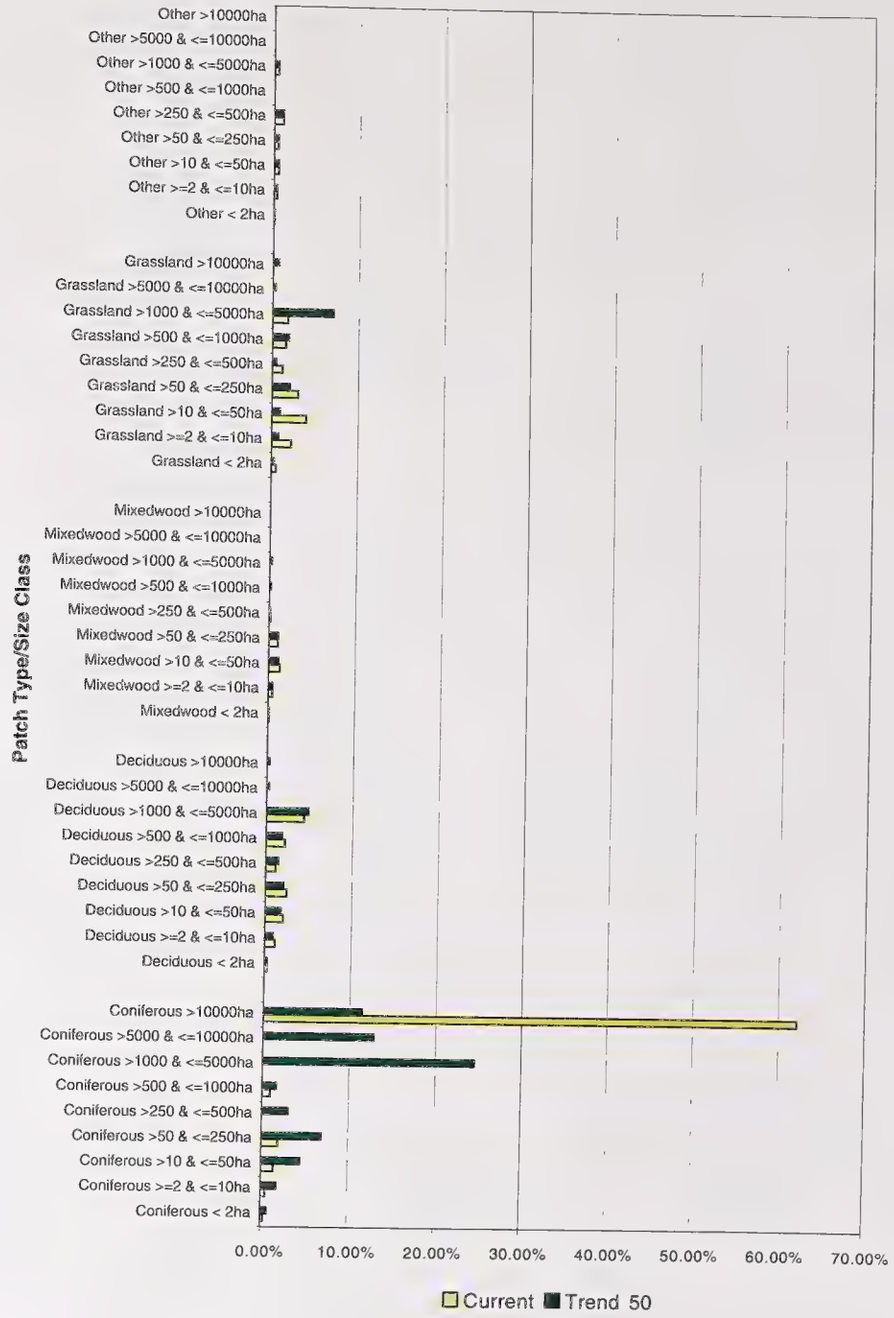


Figure 124. Coniferous, Deciduous, Mixedwood, Grassland, Other Patch Size – Trend 50 – Porcupine Hill

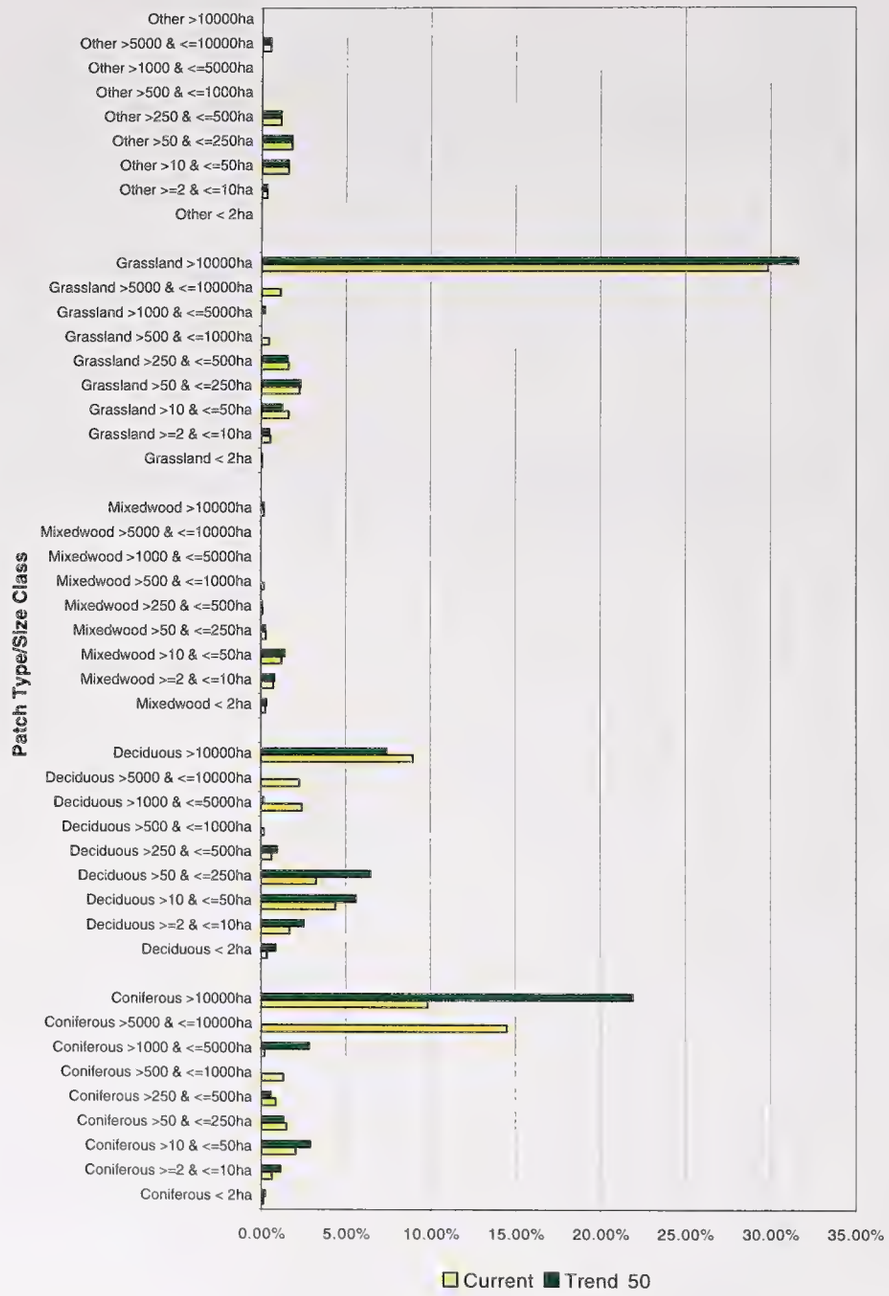
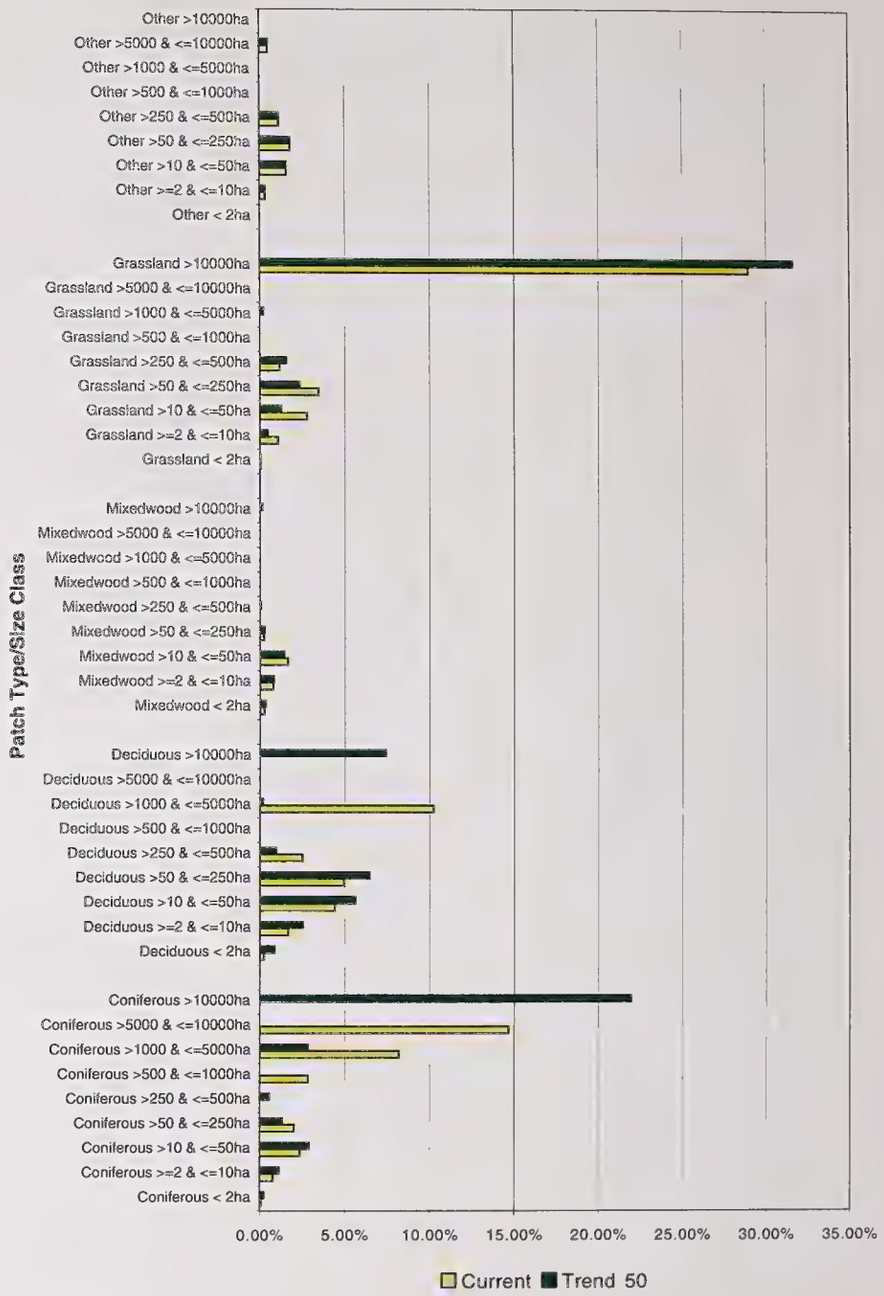


Figure 125. Coniferous, Deciduous, Mixedwood, Grassland, Other Patch Size – Fibre 50 – Porcupine Hills



4.2. CULTURAL/ECONOMIC EVALUATION AND IMPACTS

The following sections outline some of the socio–economic impacts of the various scenarios. Grazing supply, wood supply, construction activity and availability of access and visual quality are considered in the analysis. A computerized economic model of the area has also been constructed.

4.2.1. SOUTHERN ROCKIES ECONOMIC MODEL (SREM)

The Southern Rockies Economic Model (SREM) (Ellis, 1999) is a two–region economic impact model that can be used to access how changes in economic activity over time affect the Southern Rockies Landscape Planning Economic Region and the rest of Alberta.

In a two–region model, an increase in demand in region one will produce direct, indirect and induced impacts in that region, but it will also, to the extent of trade between the two regions, produce indirect and induced production in region two. The smaller region includes all the Southern Rockies pilot area and all the neighbouring communities as far east as Highway #2. The smaller region needed to be larger than the GIS study area as there were few people actually living in the study area. An area was chosen that included the locations where many of the people who are dependent on the GIS area live. In addition, some economic base line data was available only for the somewhat larger area. The entire province of Alberta forms the larger region and was chosen as provincial decision makers are interested in impacts to both the provincial and more local economies.

The SREM is comprised of an input–output model that has a demographic and labour force component and to which a time dimension has been added so results can be produced in constant dollars over a one to twenty year period. The primary data sources are the Census, the Alberta Treasury Statistics Branch's Employers Survey and Statistics Canada's business and economic survey data. The input–output structure was based on availability of data and other resource limitations.

Each of the two regions in the SREM contains 18 industries and 46 commodities. The model produces estimates for impacts on Gross Production, Gross Domestic Product (GDP), Labour Income, employment, personal taxes, demographic and labour force activity. The results produced for the variables are presented in value terms and as multipliers.

The model presents results for both the "open" and "closed" version of the model. The open version of the model includes direct and indirect impacts, while the closed version includes induced impacts as well. Indirect impacts result from businesses that supply "intermediate" inputs to the industries producing for the direct requirements.

For the closed version of the SREM, the household sector has been treated as a production sector. Here, the input of the household sector is consumer expenditure on goods and services, while output is labour income (consisting of wages and salaries, supplementary labour income and net income of unincorporated businesses). It is assumed that the households, after withdrawing a portion for savings and taxes, spend their incomes on consumer goods and services. Closing the model to households increases the interdependence of the system and results in a higher impact on the variables of the model leading to multipliers of a larger magnitude than those based on the open version. The impacts of closing the system to households are referred to as induced effects.

The SREM also has a demographic and labour force component. The base case population has been projected using actual historical births and deaths and migration patterns for the region. The labour force data for the base case is taken from the 1996 Census for the region. The existing labour force participation and unemployment rates are carried forward for the base case.

4.2.1.1. THE RESULTS OF THE ECONOMIC SIMULATIONS

A simulation using the SREM was done for each of the five scenarios. All scenarios were run for a period of 10 years and all values are presented in constant 1998 dollars and represent average annual impacts for the period. While many other GIS models were run for 50 years, the economic model was run for only 10 years as that was seen as the limit for reliable forecasting. The results are shown as changes from the baseline (current) economic profile of the area. In the baseline, the harvest level is approximately 120,000 m^3 and gas production is considerably below the long–term estimated potential for the area.

Input Data for the Scenarios

Table 13a summarizes the input data by sector for each of the five scenarios. The input data for all sectors represents average annual economic activity. For the forestry industry, if the harvest fell below the baseline, the residual was considered as an opportunity cost and not measured in the simulation (i.e., the industry cannot contract beyond its current level as reflected in the baseline).

Impacts by Scenario

Table 13b indicates the impacts of the various scenarios on the different sectors. These are discussed by sector and by scenario as follows:

Table 13. Economic Impacts by Scenario

Table13a. Economic Input Data Used for the Scenarios

			Scenario 1 Trend	Scenario 2 Disturbance	Scenario 3 Full Fibre	Scenario 4 Preservation	Scenario 5 Recreation
Agriculture (AUMs)			147,409	151,506	134,963	147,251	145,561
Forestry (000's m3)							
	New level of output		247,416	-276,449	444,287	-252,845	17,752
	Baseline output		120,000	120,000	120,000	120,000	120,000
		Impact on baseline	127,416	-120,000	324,287	-120,000	-102,248
		Residual - opportunity cost	0	-158,449	0	-132,845	0
	Prescribed burns (ha/yr)		0	0	0	3,800	0
Gas Recovery (000,000's m3)			1,633	1,633	1,633	619	1,633

Table 13b. Scenario Impacts on the Southern Rockies Region for 2000-2009

Average Annual Impacts (000's of constant $1998)		Scenario 1 Trend	Scenario 2 Disturbance	Scenario 3 Full Fibre	Scenario 4 Preservation	Scenario 5 Recreation
Summary of All Sectors						
	Gross Domestic Product	114,236	79,539	141,579	22,375	98,131
	Employment (Person-Years)	1,502	697	2,132	137	1,358
	Personal Taxes	20,354	10,433	28,199	1,468	15,090
	Unemployment rate	6.6%	7.0%	6.4%	9.6%	6.2%
Forestry Sector						
	Gross Domestic Product	17,930	-16,886	45,633	-16,886	-14,388
	Employment (Person-Years)	417	-393	1,062	-393	-335
	Personal Taxes	5,121	-4,823	13,033	-4,823	-4,109
	Unemployment rate	8.3%	12.1%	6.3%	12.1%	11.8%
Natural Gas Sector						
	Gross Domestic Product	92,032	92,032	92,032	34,885	92,032
	Employment (Person-Years)	909	909	909	345	909
	Personal Taxes	14,437	14,437	14,437	5,473	14,437
	Unemployment rate	6.2%	6.2%	6.2%	8.6%	6.2%
Prescribed Burns						
	Gross Domestic Product	0	0	0	102	0
	Employment (Person-Years)	0	0	0	10	0
	Personal Taxes	0	0	0	23	0
	Unemployment rate	0.0%	0.0%	0.0%	10.2%	0.0%
Agriculture Sector						
	Gross Domestic Product	4,273	4,391	3,912	4,268	4,219
	Employment (Person-Years)	176	180	161	175	173
	Personal Taxes	796	818	729	795	786
	Unemployment rate	9.4%	9.4%	9.5%	9.4%	9.4%
Recreation Sector						
	Gross Domestic Product	0	0	0	0	16,266
	Employment (Person-Years)	0	0	0	0	610
	Personal Taxes	0	0	0	0	3,976
	Unemployment rate	0.0%	0.0%	0.0%	0.0%	7.4%

Forestry Sector
The current baseline harvest rate of 120,000 m^3 is below what is allowable under existing ground rules that are represented by the Trend Scenario. Harvesting at the maximum AAC under the current ground rules results in an increase in the harvest rate of 127,416 m^3 or slightly more than double the current rate. This has a significant impact on the projected GDP in the region with an increase of more than $27 million. Maximizing harvest levels under the Fibre Scenario further increases the harvest level by 324,287 m^3 over the baseline and results in an increase in GDP of approximately $70 million (3% increase). Employment rates, however, stay the same for these two scenarios at 7% which is 3% lower than the baseline case. The Disturbance and Preservation Scenarios both show significant decreases to the regional economy with a loss of $26 million in GDP. The Recreation Scenario is only slightly better than the Disturbance and Preservation Scenarios as harvest levels are still below the baseline scenario.

Natural Gas Sector
While the actual rate of extraction may differ, the assumption for the natural gas sector is that the estimated potential reserves in the area will be produced over a period of 20 years at an average annual production rate of 1,633 million m^3 for all but the Preservation Scenario, where the production is only allowed outside the green zone at an annual rate of 675 million m^3. These production rates result in significant increases to the GDP or the area with an increase of approximately $95 million for all but the Preservation Scenario, which has an increase of $36 million. Unemployment rates drop to 6% and 9%, respectively.

Agriculture Sector
The agriculture sector is modelled using available Animal Unit Months (AUMs) as the input. AUMs vary from a high of 151,506 for the Disturbance Scenario to a low of 134,963 in the Full Fibre Scenario. Impacts on GDP are not large and there is no impact on the unemployment rate.

Recreation Sector
The recreation sector only varies from the baseline case in the Recreation Scenario. There is a projected increase in GDP of $18 million in this scenario with a decrease in the unemployment rate to 7%. The number of person–years of employment has increased significantly, but the lower paying jobs do not result in as large an increase in GDP as a similar increase in the forestry sector.

Scenario One: The Trend Scenario
In the Trend Scenario over the ten–year period, there was 147,409 AUMs available for grazing and harvest of 127,406 m^3 (over the baseline) of timber. These are constant annual figures. There also was an annual recovery of 1,633 million m^3 of natural gas.

As shown in Table 13b, GDP in the Southern Rockies Region was predicted to rise by $114.2 million, while employment and personal tax revenues were predicted to rise by 1,502 person–years and $20.4 million, respectively. The unemployment rate was forecast to decrease the base case of 10% to 6.6%.

In this scenario, GDP in the natural gas sector was predicted to rise by over $92 million and provide over 900 jobs and $14.4 million in personal tax revenues. The expansion of the forestry sector was predicted to lead to an increase in GDP of $18 million, in employment of 417 jobs and in tax revenues of $5.1 million. Agriculture was predicted to contribute $4.3 million to GDP and 176 jobs and $0.8 million in personal tax revenues. The Trend Scenario was the second highest of all of the five scenarios in terms of overall positive economic impacts to the region.

Scenario Two: The Disturbance Scenario
In the Disturbance Scenario, there were an annual average of 151,506 AUMs available for grazing and a loss due to fire of 120,000 m^3 of timber that would normally have been harvested. In addition, there was an annual recovery of 1,633 million m^3 of natural gas. It was further assumed that there were no salvage operations and no fire suppression was undertaken. As shown in Table 13b, GDP in the Southern Rockies Region was predicted to rise by $79.5 million, employment by 697 person–years and personal tax revenues by $10.4 million. The unemployment rate was forecast to fall from the base case of 10% to 7%.

The natural gas sector made the largest positive contribution to overall growth and more than offset the loss in the forestry sector in this scenario. GDP in the natural gas sector was predicted to rise by over $92 million and provide over 900 jobs and $14.4 million in personal tax revenues. The virtual shutdown of the forestry sector was predicted to cause a fall of $16.9 million in GDP and cost almost 393 jobs and a loss of $4.8 million in personal tax revenues. Agriculture, which made a positive contribution to all scenarios, was predicted to add $4.4 million to GDP, provide 180 jobs and added $0.8 million in personal tax revenues. The Disturbance Scenario ranked fourth of the five scenarios in terms of overall positive impacts to the region.

Scenario Three: The Full Fibre Scenario
In the Full Fibre Scenario, there was an annual average of 134,963 AUMs available for grazing and an increase over the baseline volume harvest of 324,000 m^3 of timber. In addition, there was 1,633 million m^3 of natural gas recovered each year.

The net impact of these economic changes in the Southern Rockies Region was an average annual rise in GDP of $142 million and an increase of 2,132 person–years of employment and $28.2 million in personal tax revenues. It was also predicted that the unemployment rate would fall from the base case of 10% to 6.4%.

In this scenario, GDP in the natural gas sector was predicted to rise by over $92 million and provide over 900 jobs and $14.4 million in personal tax revenues. The expansion of the forestry sector was predicted to increase GDP by $45.6 million, employment by 1,062 and personal tax revenues by $13.0 million. In addition, agriculture was predicted to contribute $3.9 million to GDP and 161 jobs and $0.7 million in personal tax revenues.

This was the only scenario where it was predicted that the forestry sector would provide more employment and personal tax revenues than the natural gas sector (although the natural gas sector would still provide a larger contribution to GDP because it is more capital and less labour intensive). The Full Fibre Scenario ranked first, by a significant margin, among all five scenarios in terms of contribution to positive regional impacts.

Scenario Four: The Preservation Scenario
In the Preservation Scenario, there were 147,251 AUMs available for grazing and a loss due to prescribed burns of 120,000 m^3 of timber that would normally have been harvested. The costs (which represent positive economic activity) of the prescribed burns was $380,000 per year. There was also an annual recovery of 619 million m^3 of natural gas.

As shown in Table 13b, GDP in the Southern Rockies Region was predicted to rise by $22.4 million, while employment and personal tax revenues were predicted to rise by 137 person–years and $1.5 million, respectively. The unemployment rate was forecast to fall marginally from the base case of 10% to 9.6%.

In this scenario, GDP in the natural gas sector was predicted to rise by over $35 million, significantly lower than other scenarios as no production was allowed within the green zone. This activity would provide 345 jobs and $5.5 million in personal tax revenues. The shutdown of the forestry sector was predicted to lead to a fall of $17 million in GDP and cost almost 400 jobs with a loss of $4.8 million in personal tax revenues. Agriculture, which made a positive contribution to all scenarios, was predicted to contribute $4.3 million to GDP, provide 175 jobs and add $0.8 million in personal tax revenues.

The Preservation Scenario was the lowest, by a significant margin, of all of the five scenarios in terms of overall positive impacts to the region.

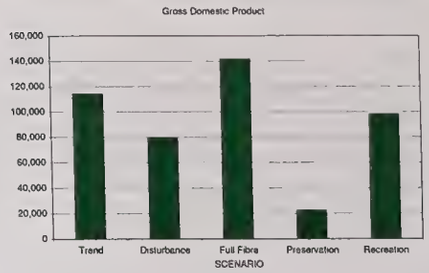
Scenario Five: The Recreation Scenario
In the Recreation Scenario over the 10–year period, there was 145,561 AUMs available for grazing and a fall in the baseline annual harvest of 102,248 m^3 of timber. In place of the forestry activity, it was assumed that there would be the construction and operation of seven backcountry lodges and three major hotel developments. Capital construction is assumed to occur over the first three years of the scenario. There was also 1,633 million m^3 of natural gas available for recovery each year.

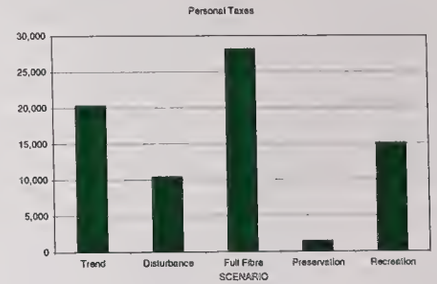
As shown in Table 13b, the Recreational Scenario was predicted to lead to a rise of $98.1 in GDP in the Southern Rockies Region and contribute 1,358 jobs and $15.1 million in personal tax revenues. The unemployment rate for the Southern Rockies Region was forecast to decrease from the base case of 10% to 6.2%.

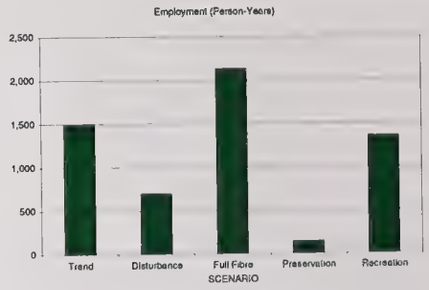
In this scenario, GDP in the natural gas sector was predicted to rise by over $92 million and provide over 900 jobs and $14.4 million in personal tax revenues. The significant fall in the output of the forestry sector was predicted to lead to a drop of $14 million in GDP and cost 335 jobs with a loss of $4.1 million in personal tax revenues. The establishment of the new recreation sector was estimated to contribute $16.3 million to GDP and provide 610 jobs and $4.0 million in tax revenues. Agriculture was predicted to contribute $4.2 million to GDP and 173 jobs and $0.8 million in personal tax revenues.

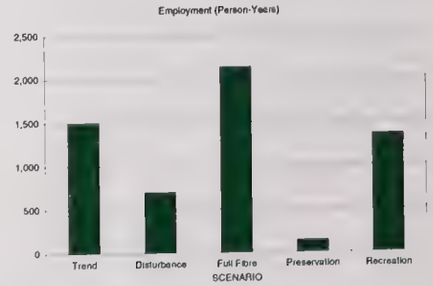
The Recreation Scenario was the third highest of all of the five scenarios in terms of overall positive impacts to the region.

Figure 126. Economic Impacts by Scenario









4.2.2. GRAZING SUPPLY

Grazing resources in the area are of exceptional importance to local ranchers. Much of the study area outside of the forest reserve is comprised of very large ranches dating to the turn of the century. These lands form an important cultural landscape that has been maintained both by periodic burning and extensive grazing. Perhaps more than any other part of the province, these rangelands typify the expansive western image of Alberta. Ranchers rely on private rangelands as well as those within White Area leases and Green Area allotments. The economic viability of the ranches and, indirectly, the protection of the cultural landscape, rely on access to extensive rangelands. Substantial changes in the available grazing supply would have serious consequences for many ranchers.

A grazing supply model was created to determine the effects of the various scenarios on the potential forage reserves. A forage productivity rating in Animal Unit Months (AUMs) per unit area was calculated for all ecosite phases. This calculation included modifications for elevation and degree of slope as well as a classification of primary and secondary range. Primary rangelands, which are those most preferred by livestock, were identified. In the Southern Rockies Landscape Planning Pilot Study, these are grasslands on lower slope positions, benchlands and terraces. Secondary ranges are those areas not grazed until the primary range resources have been heavily utilized. These are areas on steeper slopes, deciduous forest or more distant from water. Non–use rangelands were also identified. These include all closed canopy conifer stands, wet sedge meadows and closed wet shrublands. Non–use lands are assigned a rating of 0.

Productivity of ecosite phases was assigned on the basis of expected grass, forb and shrub composition. Primary ecosite phase classification was utilized and horizontal structure was not considered. A safe use factor was also assumed (using 50% of the grassland production and 25% of the forested ecosite production).

The model calculates the available AUMs per pixel as well as reporting for both the total study area and individual allotments. Table 14 indicates the total AUMs available in the entire study area as well as on allotments, crown, grazing permits and grazing leases (ACPL). The total number of AUMs calculated for the existing conditions is approximately 147,900 AUMs within the ACPL and 348,250 AUMs in the entire study area.

The changes brought about by the scenarios on potential grazing supply will have minor to moderate impacts on ranchers.

The Trend 20 does not have significant impact on grazing. However, impacts are much greater at Trend 50 with losses in productivity reaching 11.1% of the current ACPL AUMs. The Fibre Scenario also impacts grazing and represents a loss of approximately 17% of the current productivity. The changes are the result of changing ecosite phases and their associated forage value due both to harvesting and succession.

No adjustment to the figures has been made for aspen encroachment. The aspen encroachment map indicates those areas where aspen may spread into grasslands and meadows over the next 50 years. Assuming an annual encroachment rate of one meter, the loss in grassland and meadows over 50 years amounts to 15,350 ha. This represents almost 10% of the 151,300 ha of grassland and meadow dominated ecosites in the entire study area.

Figure 127. Grazing Supply – Animal Unit Months (AUMs) Graphical Model

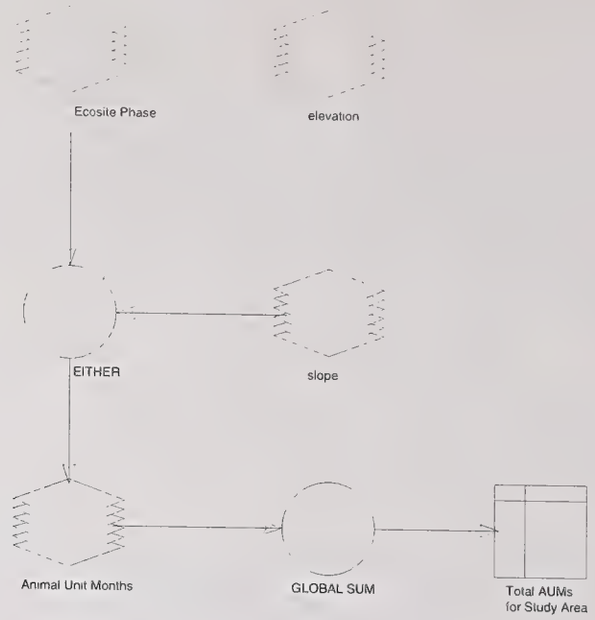


Table 14. Animal Unit Months by Scenario

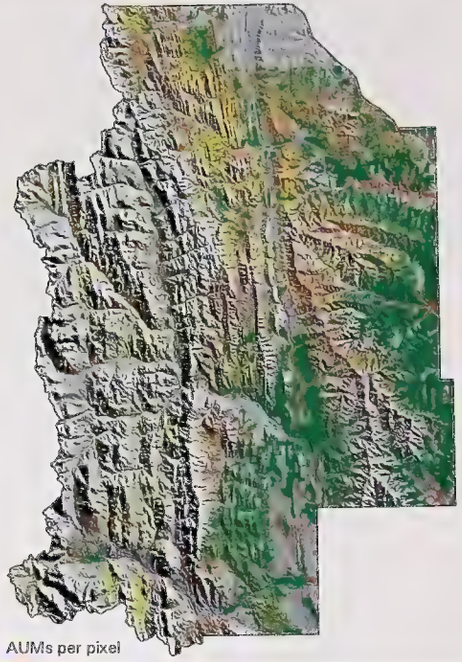
Scenario	Range Types 1 & 2 AUMs
Existing - Total Area	348244
ACPL	147870
Disturb 20 - Total Area	351017
ACPL	151506
Disturb 50 - Total Area	339798
ACPL	141353
Fibre 20 - Total Area	327595
ACPL	134963
Fibre 50 - Total Area	320046
ACPL	124620
Pres 20 - Total Area	346442
ACPL	147521
Pres 50 - Total Area	344744
ACPL	145868
Rec 20 - Total Area	345947
ACPL	145561
Rec 50 - Total Area	343070
ACPL	143293
Trend 20 - Total Area	340682
ACPL	147409
Trend 50 - Total Area	327798
ACPL	131388

ACPL = Allotments, Crown Grazing Permits and Grazing Leases on Crown lands both within and out of the forest reserve

Aspen Encroachment Areas with LMU Boundaries

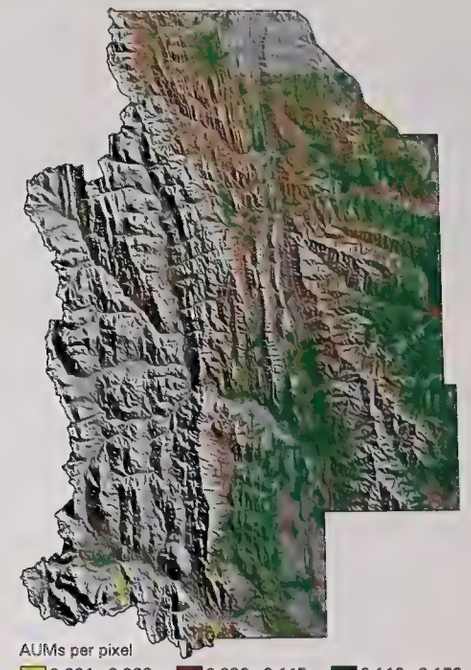
Animal Unit Months – Existing

Animal Unit Months – Trend 20



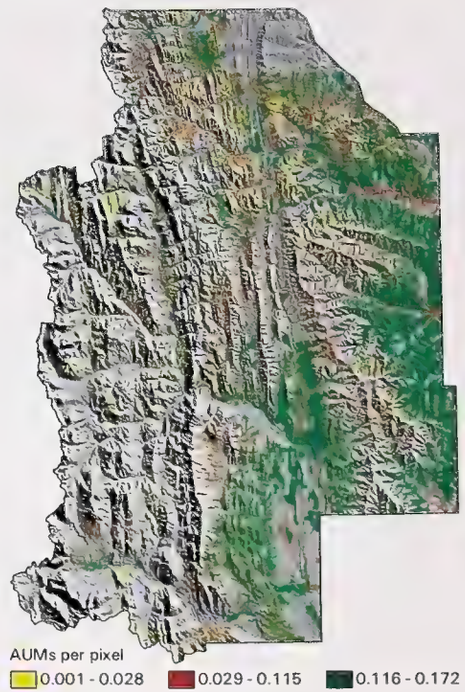
Animal Unit Months – Fibre 20

Animal Unit Months – Preservation 50

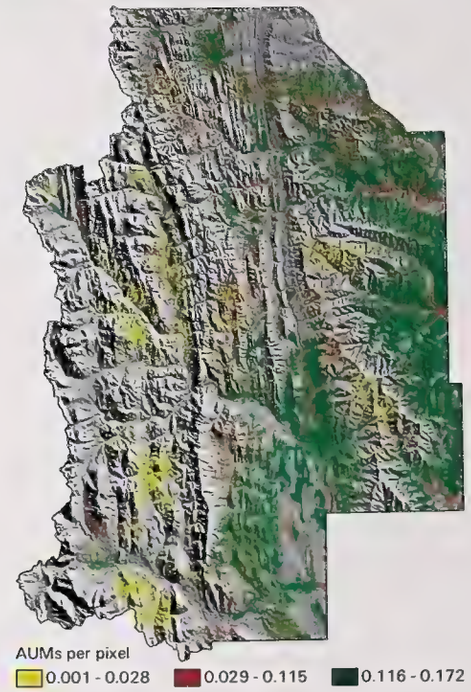


Animal Unit Months – Disturbance

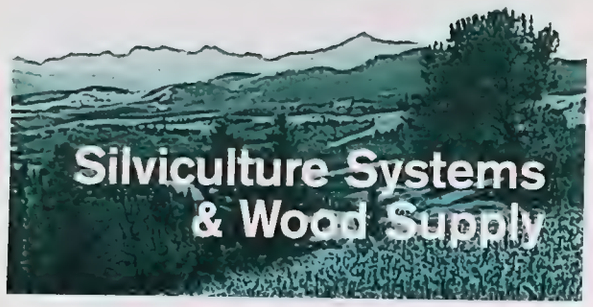
Animal Unit Months – Trend 50



Animal Unit Months – Fibre 50



Animal Unit Months – Recreation 50



4.2.3. SILVICULTURAL SYSTEMS AND WOOD SUPPLY

The production and extraction of wood fibre from the study area continues to be an economically important activity. The use of the region for forest production dates to the last century (McMillan,1909) when operations concentrated mainly in the vicinity of the Crowsnest Pass. However, the vast majority of the area has never been cut and continuous forest cover is present over much of the region. Recent forestry operations have concentrated in the Headwater Valley LMU where the impact on patch size, landscape connectivity, age class distribution, species composition, visual quality and long–term site productivity has been high. Significant cutting has also occurred in the Porcupine Hills LMU. There has been limited cutting in several other LMUs.

A dispersed system of alternate patch clearcutting is the standard silvicultural system in place throughout most of the region. The shape and configuration of the alternate patch system does not approximate the natural disturbance regime and, in time, this pattern will result in a high degree of forest fragmentation. Other possible systems for the area are outlined in the Silvicultural Typology report (Olson+Olson, 1997) but are not currently in place. A simple model for identifying areas appropriate for alternative potential silvicultural systems has been constructed that considers the forest vegetation composition, age structure and aspect. The map of Silvicultural System Options illustrates the potential options for the existing landscape.

Wood Supply

A combination of non spatial and spatial wood supply modelling has been carried out using the non spatial Woodstock optimization model by Remsoft and the spatial wood supply model Stanley by the same company. The objectives of the modelling were to spatially predict the future forest conditions under the various scenarios and to determine their impact with respect to the meeting of resource extraction objectives. Testing of the use of ecosite phase by age/height for growth and yield modelling has been an important component of the work as has been the development of successional pathways for the ecosite phases. The use of ecosite phase allows a suite of other non–fibre impacts to be modelled but it presents challenges to wood supply modelling in terms of prediction of future stand conditions, response to treatment and prediction of growth.

The growth and yield data for ecosite phase was weak due to inaccuracies in the original AVI data and the subsequent lack of correlation between mapping classes and in–field volume sampling. Additional sampling and inventory work is required in order to make more accurate projections.

Most of the modelling has been carried out in raster format. However, the wood supply modelling requires vector files and conversions were needed. The conversion methods employed were successful. Time and other constraints limited modelling to 50 years, although 180 years (or approximately two rotations) may be considered in future work.

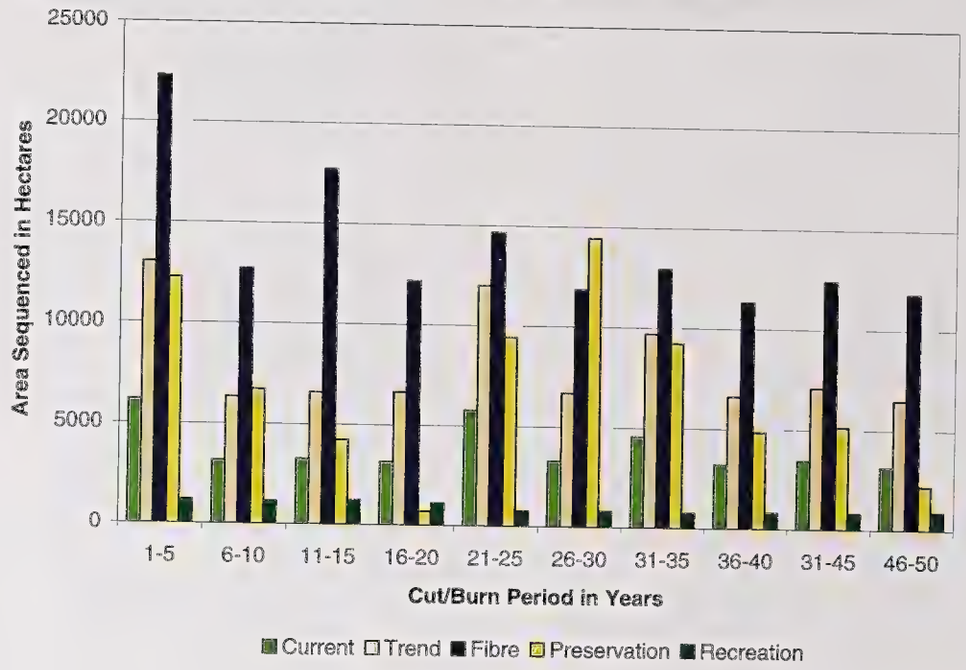
The flow of fibre from the various alternatives is variable. Figure 128 illustrates the area sequenced by 5–year cut period. The Trend Scenario cut area ranges between 6,000 to 13,000 ha per period. Over 22,000 ha will be cut in the first 5–year period of the Fibre Scenario with the area of harvest dropping thereafter. The areas indicated for the Preservation Scenario represents the area of prescribed burning as no harvesting takes place under that alternative.

It should be noted that the trend, which represents the volume that can be harvested under current operating ground rules, is almost double that which is currently being harvested. Current levels of harvest are approximately 120,000 m^3 per year or 600,000 m^3 per 5–year period.

Wood supply exhibits fairly even flow under most scenarios. The Fibre Scenario removes approximately 2,300,000 m^3 per five–year period, almost four times the amount harvested under the current actual allocations and double that of the Trend Scenario harvest levels. The Preservation Scenario indicates a spike in the period 26 – 30 years. The Recreation Scenario harvest is so small that companies now operating in the area would likely not survive.

A map of potential silvicultural systems was developed. While not used in the timber supply modelling, it may be useful in operational planning.

Figure 128. Area Sequenced (or burned in Preservation Scenario) by 5–Year Period



Silvicultural System Options (Primary Treatment Regimes)	Area(ha)
Natural Regeneration, Regime 1 (Nat 1) Leave for Natural (seed)	28117
Natural Regeneration, Regime 2 (Nat 2) Site Prepare for Natural	73506
Natural Regeneration, Regime 3 (Nat 3) Leave for Natural (seed)	26273
Natural Regeneration, Regime 4 (Nat 4) Leave for Natural (coppice)	0
Artificial Regeneration, Regime 1 (Art 1) Site Prepare and Artificial Seed	0
Artificial Regeneration, Regime 1 (Art 1*) Site Prepare and Artificial Seed Species conversion to Lodgepole Pine will result	1696
Artificial Regeneration, Regime 2 (Art 2) Site Prepare for Planting	22488
Artificial Regeneration, Regime 2 (Art 2**) Site Prepare for Planting Manage for confiers only (primarily Sw)	57245
Artificial Regeneration, Regime 3 (Art 3) No Site Preparation and Planting	82
Artificial Regeneration, Regime 3 (Art 3(2)) No Site Preparation and Planting Soil moisture deficit and seasonal drought can be significant limiting factors throughout the Montane Natural Subregion except on f and g sites	7774
Non-merchantable stands	47817
Herbaceous Clearcuts were not considered for treatment	3630

Potential Silvicultural Systems

4.2.4. ENERGY AND MINERAL RESOURCES

The resource potential for the area is very high as there are substantial proven gas reserves and very good potential for more. The overall potential is ranked in the highest category due to the presence and size of reserves. The potential gas in place has been estimated at 35.5 billion m^3 in the entire study area. Although known and potential gas reserves are large, there are only minimal reserves of oil. While access is often difficult due to steep terrain and environmental constraints, there is a strong likelihood of future exploration. The level of exploration is considered as low despite the seemingly extensive seismic line network. Coal potential is also very good and there have been mines in the area since the turn of the century, although none are currently active.

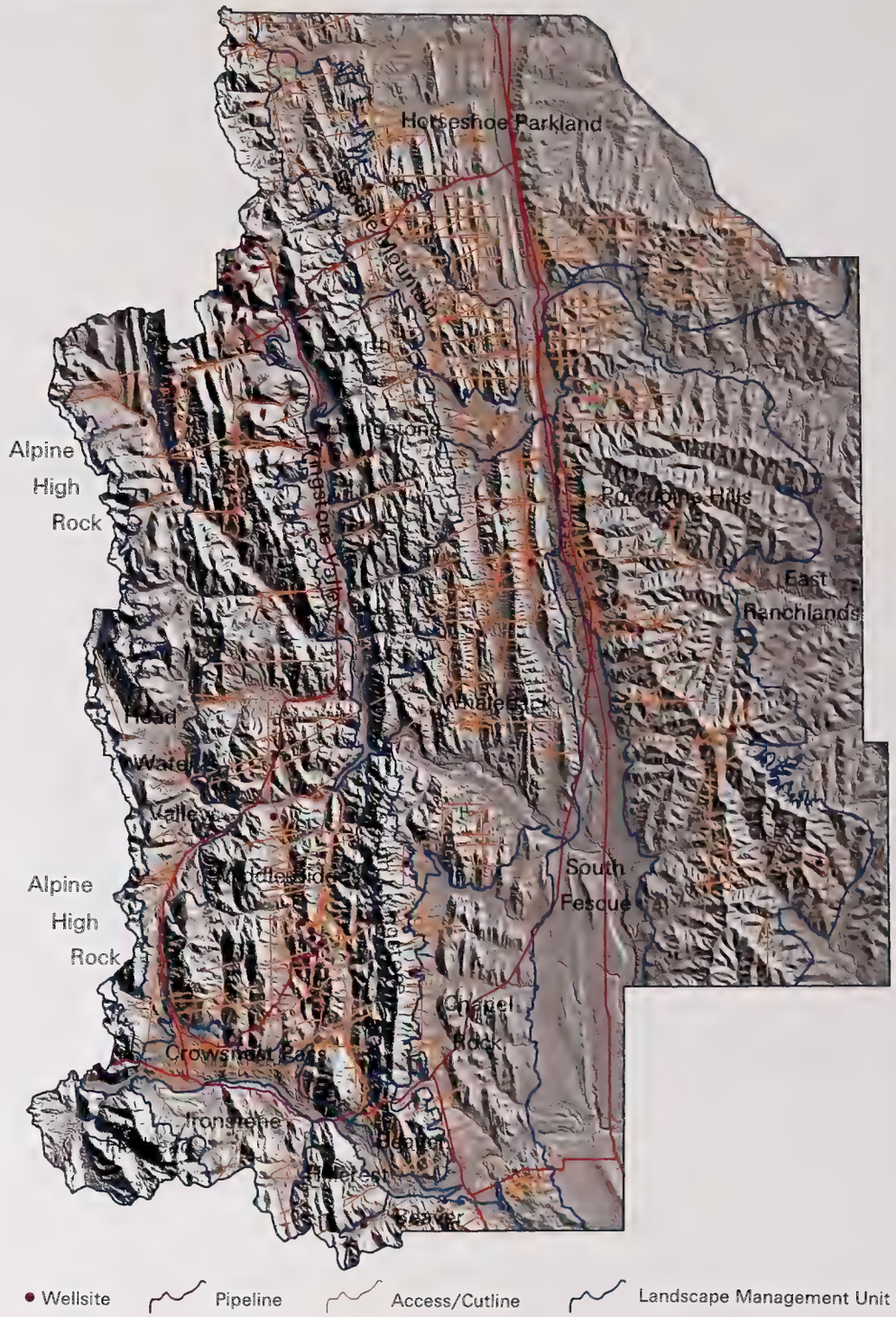
Oil and gas operations are almost certain to continue throughout the region due to the substantial potential reserves. Seismic operations, wellsite development, pipeline and road construction are the main activities of disturbance related to energy exploration, production and distribution. Recent seismic activities are usually portable helicopter operations and result in cutlines of narrower width. The ecological impact of the portable lines is generally low and associated forest fragmentation issues are usually minor. There are potential visual impact issues in some areas due to the continuous forest cover and high visual sensitivity of much of the region.

Wellsite construction and maintenance, together with the associated human activity along roadways, is a potentially significant disturbance from a number of perspectives (impact of both construction and operation as well as that of access). Gas transmission lines and power lines fragment by dissecting natural patches and have associated ecological and visual impacts (Harris, 1984). The total "footprint" of the oil and gas operations in the area is noted on the map of energy related operations (Oil and Gas Footprint). Seismic lines, wellsites, transmission lines and associated roads are indicated.

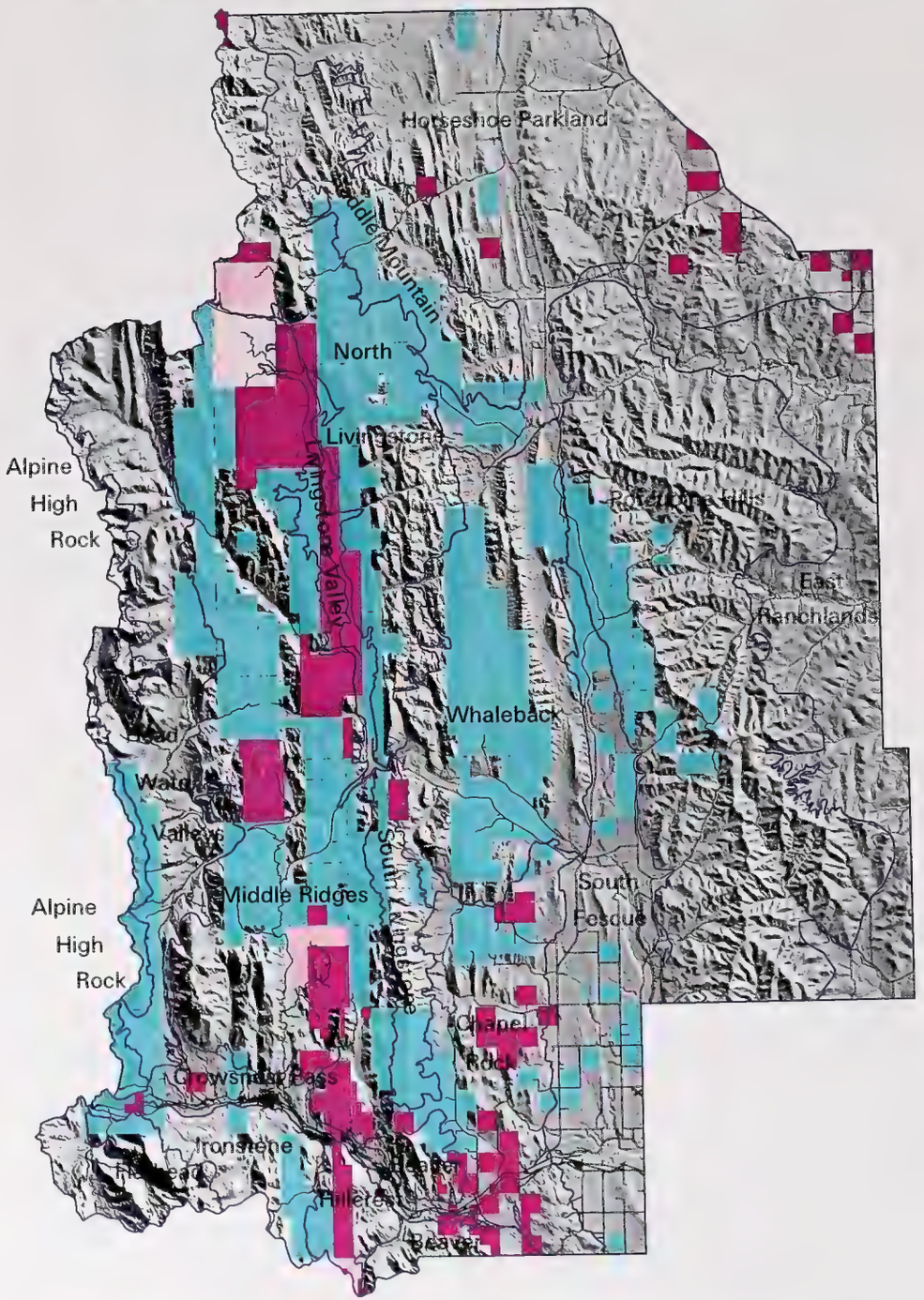
The impact of the scenarios on energy–related activity is, for the most part, extremely limited with one serious exception. In the Preservation Scenario, all industrial activity is excluded. As indicated in the maps of leases for oil and gas as well as coal and mineral reserves, the area is largely blanketed with leases and any attempt to suppress activities will likely be extremely costly. Rough estimates from the map of potential gas reserves indicates that there are over 22 billion m^3 of gas on Crown land in the study area. The cost of excluding extraction from Crown Land is therefore, enormous.

Potential Gas in Place

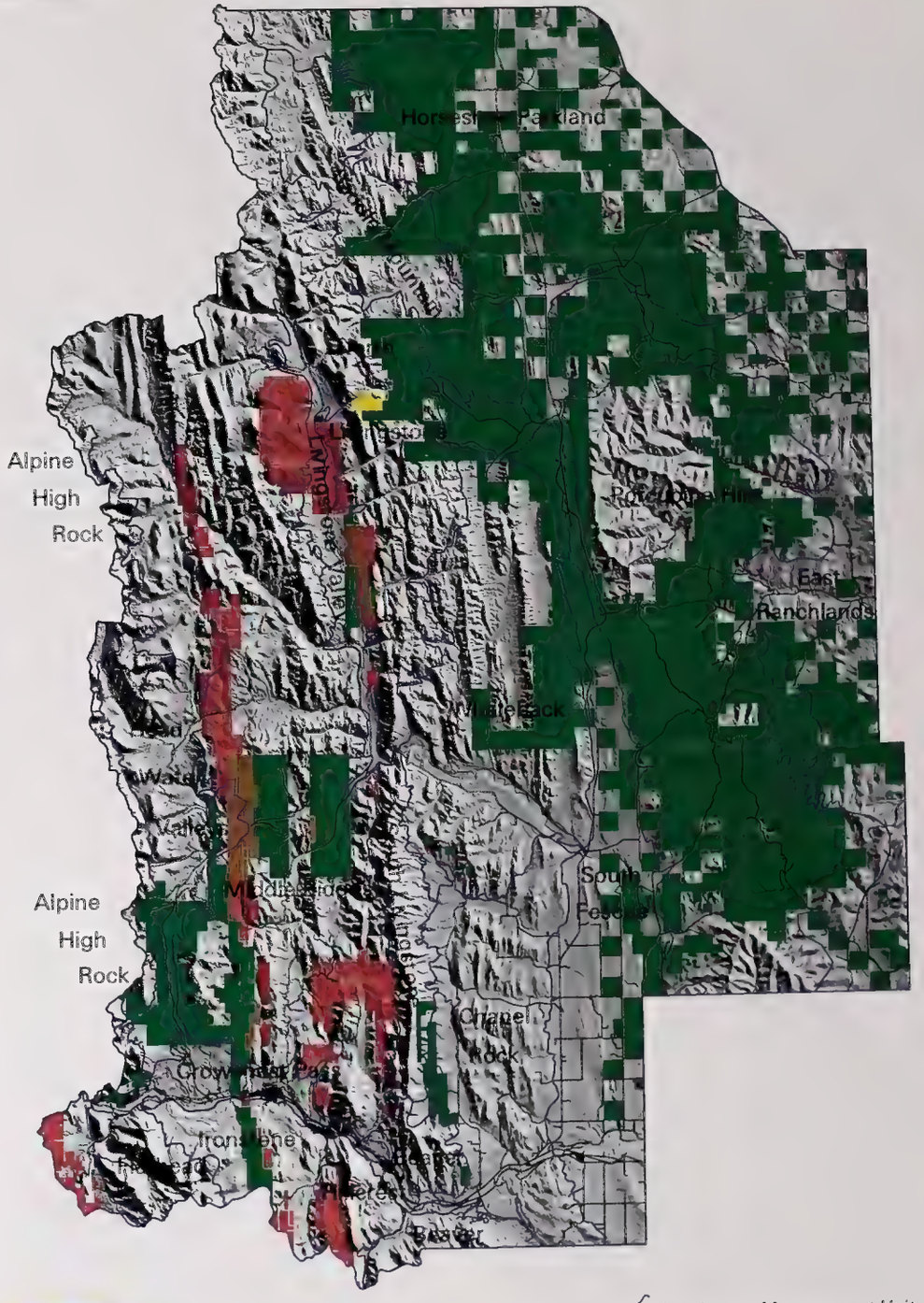
Oil & Gas Infrastructure



Oil & Gas Leases and Licenses



Mineral Leases



4.2.5. ACCESS

Much of the study area is easily accessible by roads and trails. There are over 1,280 km of roads in the area, not including truck trails, and over 6,000 km of trails and cutlines, ranging in size from seismic lines and minor logging roads to little more than horse trails. A major rail line and a major highway (#3) run through the Crowsnest Pass. Highway #22 runs north south along the west side of the Porcupine Hills.

Due to their extent, broad distribution and associated activities, roads have had the greatest ecological and visual impact of any human disturbance in the region to date. Both in terms of construction methods and access management, roads present one of the greatest challenges to planning. They are one of the major impacts on watersheds and often divert shallow subsurface flows to surface drainage swales, ditches and ultimately to streams. Bridges, culverts and stream crossings all have the potential to impact water quality. In addition, the access that roads bring to otherwise remote areas causes significant impact on many wildlife species, particularly large carnivores. Human access is of particular concern to grizzly bears because of the bear/human interactions that reduce effective utilization of the habitat or cause increased habituation that has been linked to increased mortality. In addition, the visual impact of roads can be one of the most difficult aspects of harvesting to manage. The direct impact of the loss of area of productive vegetative cover may be significant, as is the long–term reduction in productivity from skid trail construction.

For the purposes of the several models used in the study, access has been classified into three categories:

Access Type A – All Weather: Paved roads, gravel two lane, gravel one lane, Main Rail Lines

Access Type B – Good Weather: Unimproved roads, Truck Trails, Spur Rail Lines

Access Type C – Backcountry: Trail/cutline and Utility Corridor

Access changes under the various scenarios, except for the Disturbance Scenario where it is assumed to remain the same. Under both the Trend and Fibre Scenarios, all roads that are constructed for harvesting purposes are assumed to remain in place with no decommissioning. Under the Recreation Scenario, a roadless area restricted to foot and horse traffic only is put in place throughout the Headwater Valley Landscape Management Unit. A comprehensive trail system is also constructed (utilizing for the most part, existing trails). In addition, a motorized vehicle zone, similar to the Mclean Creek area in Kananaskis Country, is designated in the Recreation Scenario.

The Preservation Scenario removes all roads from the Forest Reserve except for the Kananaskis Trail. This results in significant improvements in the effectiveness of grizzly habitat, but also restricts recreational access.

The Trend 50 results in slightly more roading than the Fibre 50 Scenario. This may be caused by the smaller cutblocks in the Trend Scenario and the additional roads required to access them. Both scenarios result in a significant increase in access to the area and fragmentation of the region.

Table 15 indicates the amount and type of access that now exists in the region under the various scenarios. Table 16 indicates the access by the three classifications listed above.

Table 15. Amount and Type of Access by Scenario

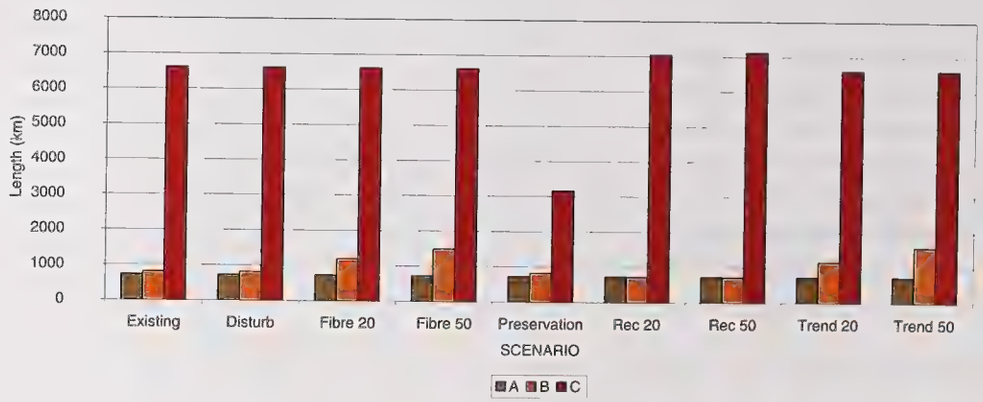
Class Type	Access Class	Existing Length (km)	Disturb Length (km)	Fibre 20 Length (km)	Fibre 50 Length (km)	Preservation Length (km)	Rec 20 Length (km)	Rec 50 Length (km)	Trend 20 Length (km)	Trend 50 Length (km)
Runway Airfield	1	3.468	3.468	3.468	3.468	3.468	3.468	3.468	3.468	3.468
Road Gravel 1 Lane	2	375.130	375.130	375.130	375.130	375.130	375.130	375.130	375.130	375.130
Road Gravel 2 Lanes	3	139.345	139.345	139.345	139.345	139.345	139.345	139.345	139.345	139.345
Road Paved undivided 2 Lanes	4	165.760	165.760	165.760	165.760	165.760	165.760	165.760	165.760	165.760
Road Unimproved	5	608.576	608.576	990.425	1282.519	617.041	556.991	556.991	959.246	1373.848
Trail/Cutline	6	6072.643	6072.643	6072.643	6072.643	2032.951	6834.286	6613.941	6072.643	6072.643
Trail Truck	7	197.742	197.742	197.742	197.742	198.324	152.381	152.381	197.742	197.742
Bridge Railway Trestle	8	0.370	0.370	0.370	0.370	0.370	0.370	0.370	0.370	0.370
Rail Line Single Track	9	52.340	52.340	52.340	52.340	52.340	52.340	52.340	52.340	52.340
Rail Line Spur	10	4.212	4.212	4.212	4.212	4.212	4.212	4.212	4.212	4.212
Major Pipeline	11	368.747	368.747	368.747	368.747	368.747	349.012	349.012	368.747	368.747
Transmission Line Major	12	163.204	163.204	163.204	163.204	163.204	159.602	159.602	163.204	163.204

Table 16. Amount of Access by Road Class

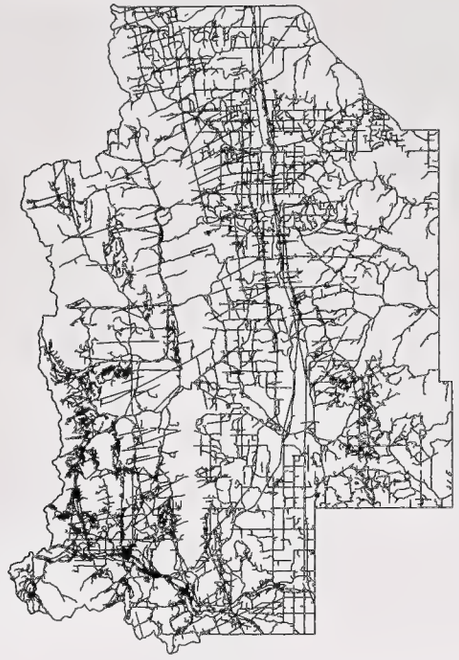
Access Type	Existing Length (km)	Disturb Length (km)	Fibre 20 Length (km)	Fibre 50 Length (km)	Preservation Length (km)	Rec 20 Length (km)	Rec 50 Length (km)	Trend 20 Length (km)	Trend 50 Length (km)
A	732.575	732.575	732.575	732.575	732.575	732.575	732.575	732.575	732.575
B	810.530	810.530	1192.379	1484.474	619.578	713.585	713.585	1161.202	1575.802
C	6604.595	6604.595	6604.595	6604.595	3164.903	7042.899	7122.555	6604.595	6604.595

NOTE: Grey areas represent areas of greatest change.

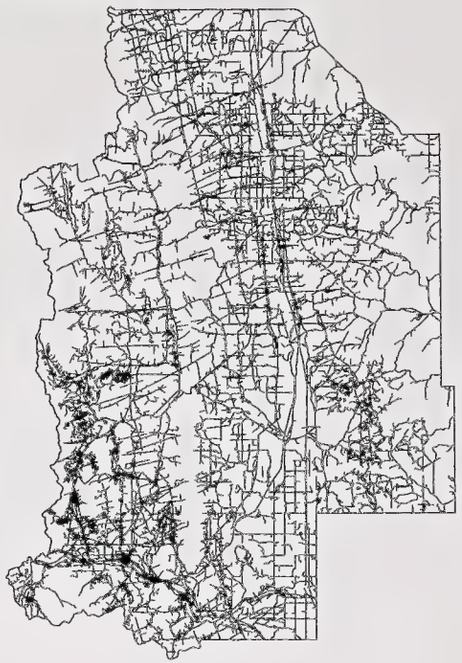
Figure 129. Length of Access by Type and Scenario



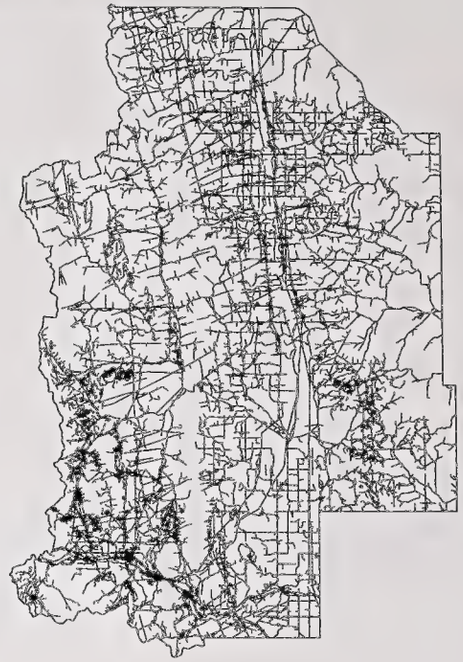
Access– Existing



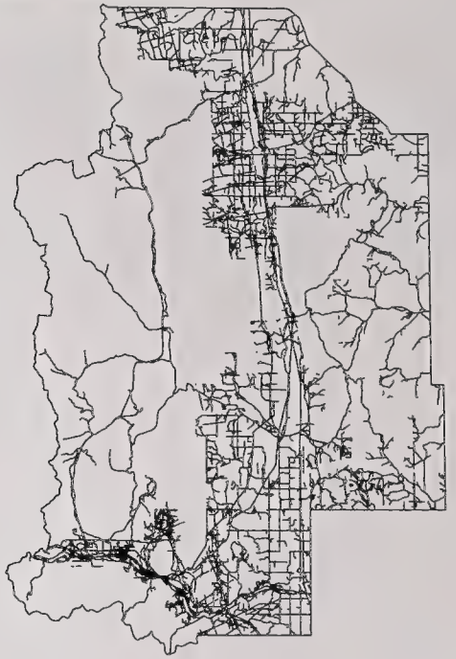
Access – Trend 20



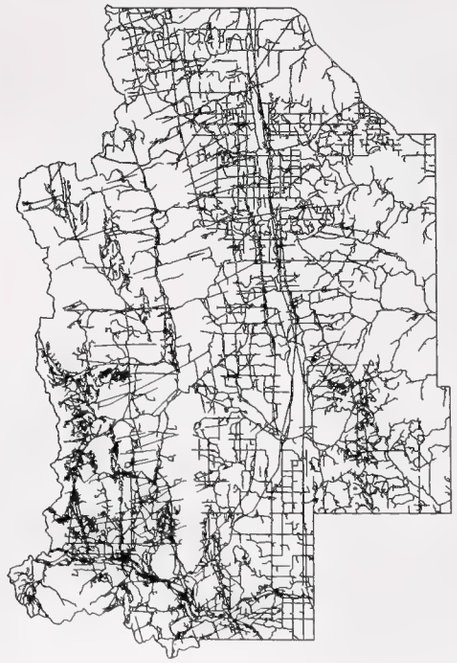
Access – Fibre 20



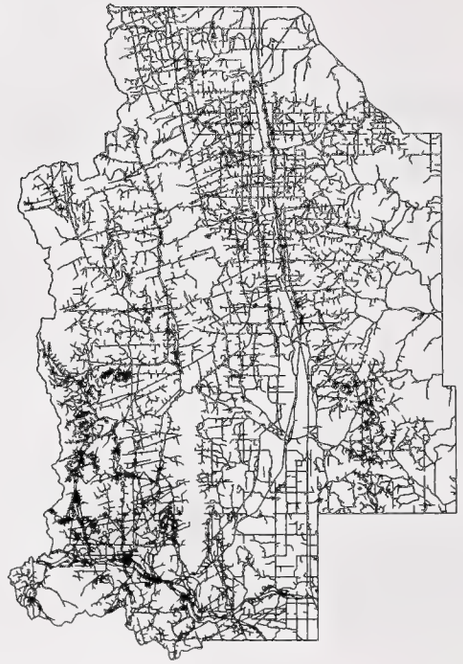
Access – Preservation 50



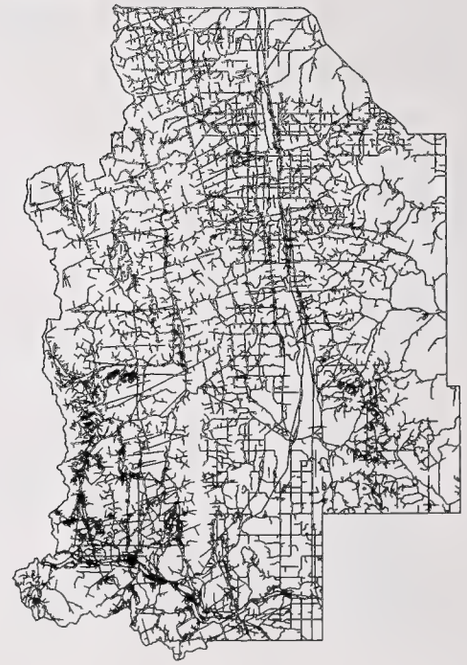
Access – Disturbance



Access – Trend 50



Access – Fibre 50



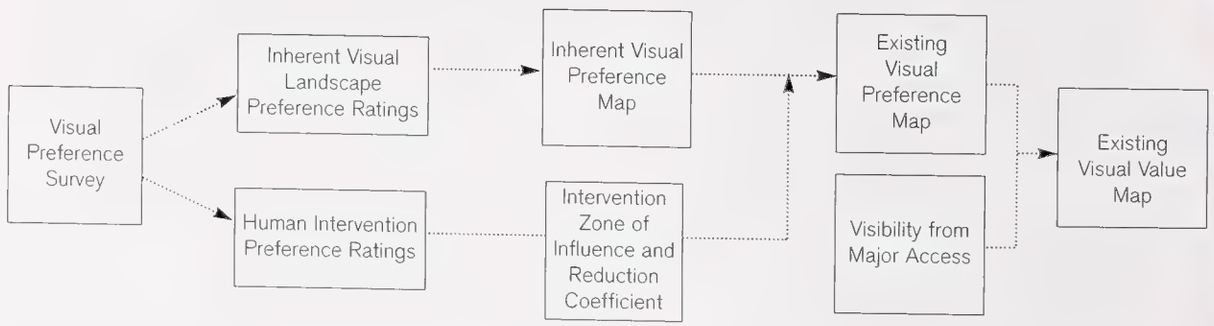
Access – Recreation 50

4.2.6. VISUAL RESOURCE MODELLING

Visual resource modelling was an important component of the study. The project area provides significant and highly valued scenic resources that need to be planned for and managed. The primary purpose of the modelling investigations were to identify, evaluate and map the visual resource value of the existing and potential future landscape. In doing so, a quantitative evaluation of the scenic landscape was developed to provide a mechanism for visual impact evaluation and informed decision–making.

Visual resource value, as determined in this study, represents a combination of public preference ratings for the visual landscape and the visual exposure (degree of visibility) of the landscape from transportation corridors. Figure 130 outlines the general model structure.

Figure 130. General Visual Model Structure


Visual Preference Survey
Inherent Visual Landscape Preference Ratings
Human Intervention Preference Ratings
Inherent Visual Preference Map
Intervention Zone of Influence and Reduction Coefficient
Existing Visual Preference Map
Visibility from Major Access
Existing Visual Value Map

VISUAL LANDSCAPE PREFERENCE

A visual preference survey was conducted to identify public perceptions towards the visual quality of the landscape. The survey was aimed at providing quantitative data that could be mapped and analyzed. Landscape preference ratings were obtained for both the inherent visual landscape (free of visually obvious human interventions) as well as existing landscapes influenced by various human interventions and management activities. Results from the survey were used to produce an Inherent Visual Preference Class map, Human Intervention Zone of Influence map and an Existing Visual Preference Class map (the inherent preference rating modified by human interventions).

Visual Preference Survey

Photographic representation was selected as the best means of obtaining preference data due to the scale of the study area, the diverse user population and the range of landscape representations. Studies have shown that photographs provide a reasonable representation of public preference and are an acceptable surrogate for the actual physical setting (Hull et al 1992; Kellomaki et al 1984; Stewart et al 1984).

The visual preference survey was conducted using a slide presentation of 93 colour photographs representing a range of unaltered landscapes and human interventions. Respondents were surveyed in Calgary, Edmonton, Lethbridge, the Crowsnest Pass and Chain Lakes. Participants were asked to independently rate each photograph on a 5–point scale ranging from 1 (very low visual preference) to 5 (very high visual preference).

Inherent Visual Landscape Preference

The inherent visual landscape represents lands that are relatively free of human interventions and activities (i.e., mining, forestry, utilities, etc.). The "land system" classification identified in the Ecological Land Classification (ELC) data for the Livingstone–Porcupine Hills region of Alberta was used to identify inherent landscape types. A set of 43 photographs was selected to represent the 76 land systems found in the study area (several photographs contained more than one land system in proximity).

A mean preference rating was calculated for each of the 43 inherent landscape photographs to establish preference ratings for the various land systems. The Inherent Visual Preference Class map represents the mean ratings categorized. In general, the results indicate three clusters of landscape systems in the preference ratings. Top ranking land systems have prominent mountain views with forested slopes or the presence of water. Middle range preference ratings corresponded to land systems with a mix of grassland, aspen and conifer slopes, whereas the lowest ratings were dominated by grassland systems. It is important to note that the vast majority of the land systems were rated as 3 and higher, implying that the region as a whole is highly preferred visually.

Influence of Human Interventions

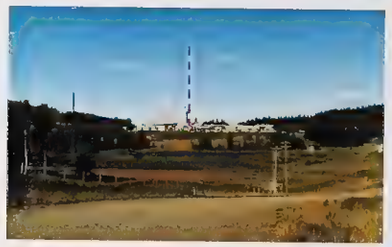
The influence of human interventions and landscape management practices on visual preference ratings were surveyed using a set of 50 photographs. Timber harvest, gas wells, transmission lines, camping and rural settlements were identified as the main interventions found within the study area. In order to measure the influence of the intervention on visual preference, photographs were computer manipulated to simulate the "before or after" condition of the landscape. In addition to measuring influences on the presence and absence of human interventions, timber harvest practices were added to the survey set in order to obtain preference ratings on harvest cut patterns types (i.e., curvilinear versus rectilinear) and post harvest management of the cutblock (i.e., brush piles – disposal).

The percent reduction in preference value between the before and after conditions was measured (the greater the difference in preference rating, the higher the preference value reduction). The findings indicated that preference rating decreased with the presence of timber harvest (rectilinear cutblocks rated lower than curvilinear cuts), wells, camping and transmission lines. Rural settlements in the form of individual farmsteads did not have significant effects on visual preference ratings. In general, the survey results indicate a preference rating reduction of 30% for landscapes with obvious human interventions. It is significant to note that of the 93 photographs used in the visual preference survey, including many forms of human interventions, the open pit mine photo scored the lowest of all.

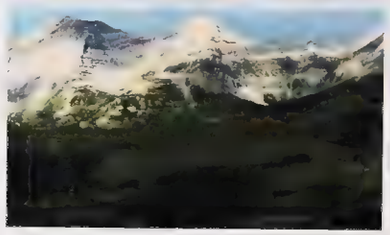
Existing Visual Preference

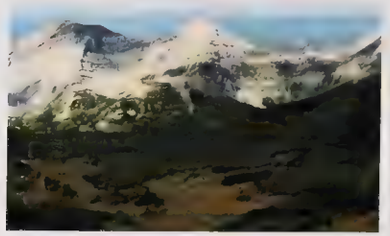
Existing visual preference is based upon the survey findings that human interventions modify the visual preference of the inherent landscape. As a result, the Existing Visual Preference map is the result of adjusting the Inherent Visual Preference ratings assigned to each land system based upon the presence of human interventions.

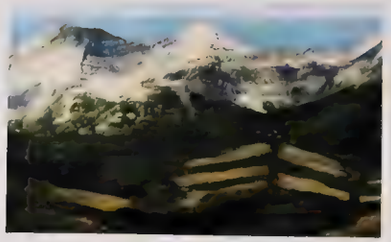
All known human intervention sites for gas wells, cutblocks, overhead transmission lines and campgrounds were identified (rural settlements were not included due to little change in preference ratings between presence and absence of settlements). An influence zone of 2 km was radiated from each intervention to determine areas from which the interventions are visible. The digital elevation model was incorporated in this process in order to adjust for variations in terrain and site lines. A reduction coefficient of 0.7 (reflecting the 30% reduction value) was assigned to both the intervention as well as all areas within the influence zone from which the intervention could be seen. This Intervention Influence map was combined (multiplied) with the Inherent Visual Preference map to produce the Existing Visual Preference Class map.


Gas plant (after intervention)

Gas plant removed (before intervention)


Existing Landscape


Curvilinear Cut Pattern


Rectilinear Cut Pattern

VISIBILITY

Visibility is defined in terms of whether areas are visible from transportation corridors, ranging from truck trails to major paved roads. The Visibility map was produced using a road network map as well as a digital elevation map with tree heights added to the base elevation values. A 360° radiate operation, at a maximum distance of 10 km, was performed from a set of vertices on the road network (all roads indicated on the map had a set of vertices). Each time a cell was seen from a vertex, it received a count of one. Terrain and tree height influenced the radiate operation and cell count. Individual cells ranged from being seen up to 591 times to not being seen at all.

Visual Value

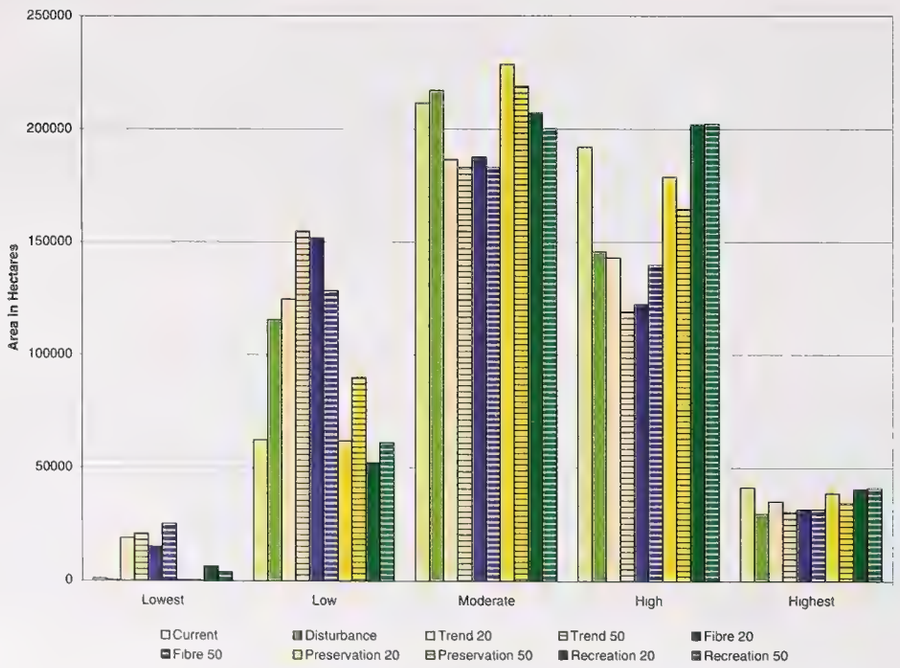
The Visual Resource Value of the scenic resources in the study area is a combination of the Existing Visual Preference ratings for landscape types and their level of visibility. The higher the preference and visibility, the greater the visual resource value. Visual resource value ratings were determined by assigning values to the unique combinations of the categories in the Visibility and the Preference Value maps. Value ratings were grouped into four visual resource value classes based upon a matrix that established class categories for the various visibility/preference value combinations. The final map displays five visual resource value classes with 1 representing the lowest and 5 the highest visual resource value.

VISUAL IMPACT OF THE SCENARIOS

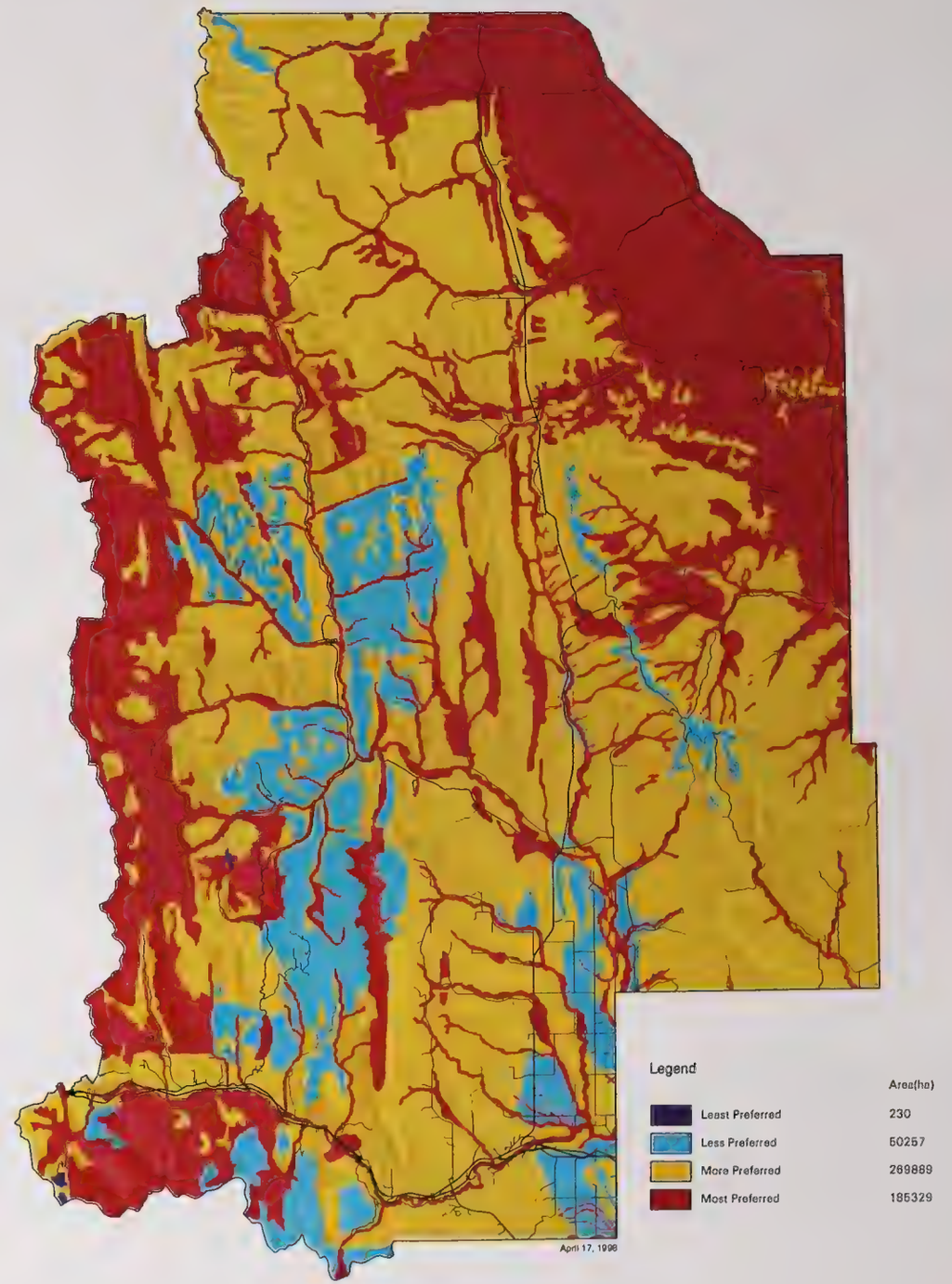
As noted, the visual quality of the landscape is currently highly valued. The scenarios impact this important resource to varying degrees. All scenarios, with the exception of the Recreation Scenario, which has neither burns nor extensive harvesting, reduce the area of the highest visual value class. The high class is also heavily impacted with both the Trend and the Fibre Scenarios reducing the area in that class by over 25%. Considering the importance of the area to recreation and tourism, this impact must be viewed as significant. The Disturbance Scenario also has a pronounced effect on Visual Value with high classes dropping significantly. The Preservation Scenario is second only to the Recreation Scenario in the protection of the visual resource. It is lower than Recreation as it employs prescribed burning (which lowers preference ratings). The Recreation Scenario does have a limited amount of harvesting but all of it is beyond the viewsheds of transportation corridors.

The visual modelling indicates that future land uses in the area have the very real potential to substantially degrade the visual character of the region. Effective techniques exist for mitigating the effect of forest operations. If the visual resource is to be protected, while at the same time maintaining current levels of harvesting, these will have to be utilized.

Figure 131. Visual Value by Scenario



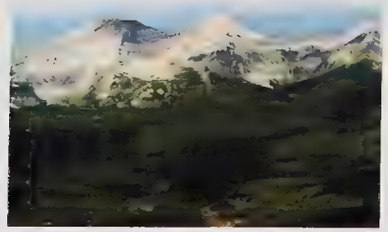
Inherent Visual Preference



(55)

Land System(s): 6F1

Mean Preference Rating: 4.75
Preference Class: 4



(13)

Land System(s): 7C1, 7CX1, 7R1, 7XR1, 7XR2

Mean Preference Rating: 4.72
Preference Class: 4

(53)

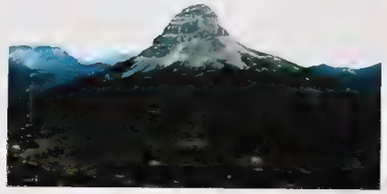
Land System(s): 6C1, 6C2, 6C3

Mean Preference Rating: 4.51
Preference Class: 4

(57)

Land System(s): 3F1, 4F2

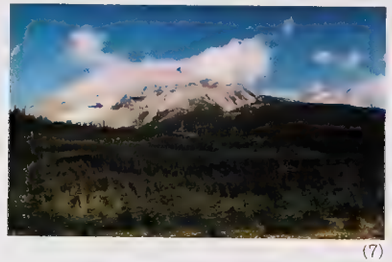
Mean Preference Rating: 4.26
Preference Class: 4



(71)

Land System(s): 6X4, 6X5

Mean Preference Rating: 4.40
Preference Class: 4



(7)

Land System(s): 6M3

Mean Preference Rating: 4.26
Preference Class: 4

(28)

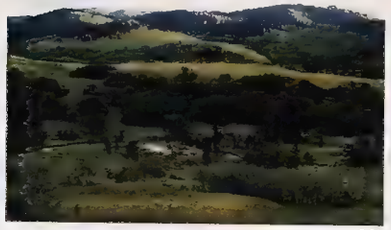
Land System(s): 3F1, 4F2

Mean Preference Rating: 4.26
Preference Class: 4

(26)

Land System(s): 4M1, 4M2

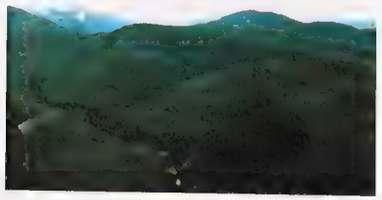
Mean Preference Rating: 4.25
Preference Class: 4



(32)

Land System(s): 4F1, 4M3

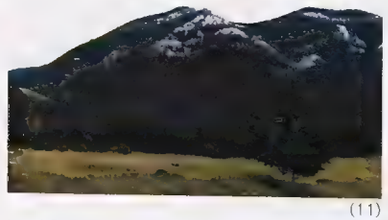
Mean Preference Rating: 4.16
Preference Class: 4



(64)

Land System(s) 6X2

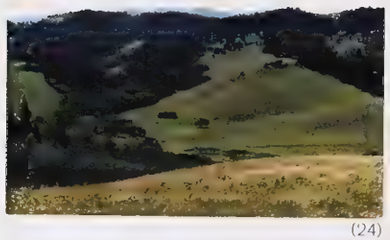
Mean Preference Rating: 4.07
Preference Class: 4



(11)

Land System(s) 6X1

Mean Preference Rating: 4.00
Preference Class: 4



(24)

Land System(s): 5MR2

Mean Preference Rating: 3.93
Preference Class: 3

(15)

Land System(s): 5M2, 5M3, 5X2

Mean Preference Rating: 3.92
Preference Class: 3

(2)

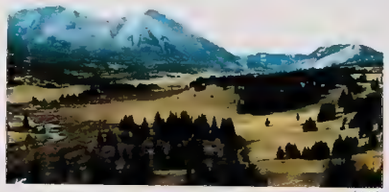
Land System(s): 3M2

Mean Preference Rating: 3.90
Preference Class: 3

(31)

Land System(s) 6X3

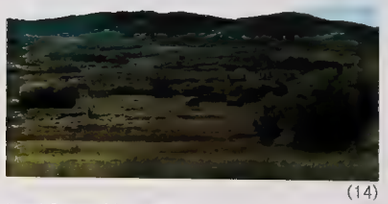
Mean Preference Rating: 3.75
Preference Class: 3



(46)

Land System(s): 5G1, 5G2, 5F1, 5F2

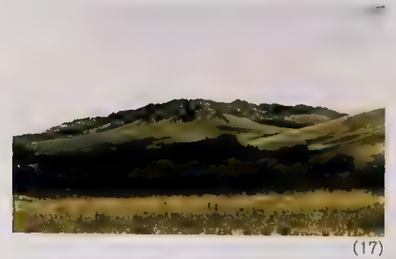
Mean Preference Rating: 3.72
Preference Class: 3



(14)

Land System(s): 4MR3

Mean Preference Rating: 3.72
Preference Class: 3



(17)

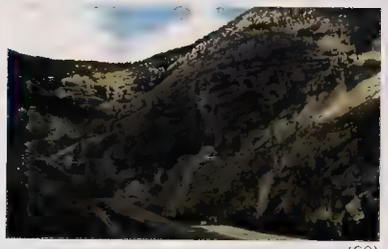
Land System(s): 5MR1

Mean Preference Rating: 3.64
Preference Class: 3

(93)

Land System(s): 3L1

Mean Preference Rating: 3.62
Preference Class: 3



(60)

Land System(s): 6RC1, 6RX1

Mean Preference Rating: 3.57
Preference Class: 3

(16)

Land System(s): 5M4, 5M5, 5X3

Mean Preference Rating: 3.55
Preference Class: 3

(23)

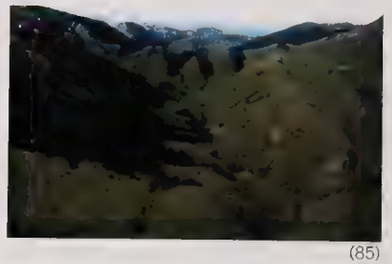
Land System(s): 3M3, 3M5, 3M6

Mean Preference Rating: 3.51
Preference Class: 3

(37)

Land System(s): 5M1

Mean Preference Rating: 3.46
Preference Class: 3



(85)

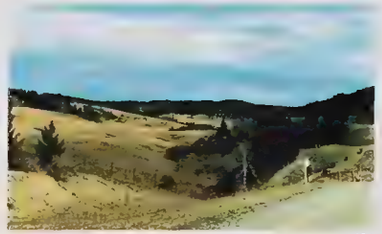
Land System(s): 6XC1

Mean Preference Rating: 3.44
Preference Class: 3

(42)

Land System(s): 5MR3

Mean Preference Rating: 3.38
Preference Class: 3



(5)

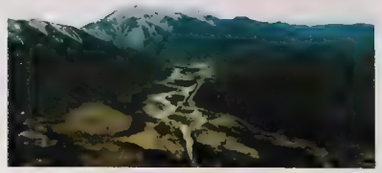
Land System(s): 3M1

Mean Preference Rating: 3.37
Preference Class: 3

(69)

Land System(s): 4MR1, 5G1, 5G3

Mean Preference Rating: 3.33
Preference Class: 3



(56)

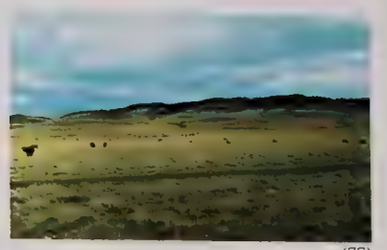
Land System(s): 6G1, 6G2

Mean Preference Rating: 3.01
Preference Class: 3

(25)

Land System(s): 3M4

Mean Preference Rating: 2.98
Preference Class: 2



(77)

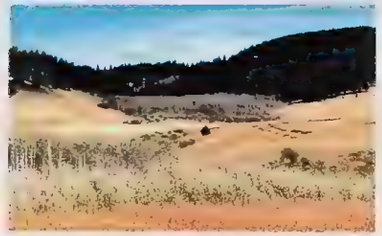
Land System(s): 3L2, 3M7

Mean Preference Rating: 2.97
Preference Class: 2

(40)

Land System(s): 4M2

Mean Preference Rating: 3.33
Preference Class: 3



(52)

Land System(s): 5MR3

Mean Preference Rating: 3.31
Preference Class: 3

(67)

Land System(s): 4MR1

Mean Preference Rating: 3.27
Preference Class: 3

(51)

Land System(s): 5X1

Mean Preference Rating: 2.88
Preference Class: 2

(75)

Land System(s): 3L1

Mean Preference Rating: 2.88
Preference Class: 2

(91)

Land System(s): 3L2, 3M7

Mean Preference Rating: 2.88
Preference Class: 2

(19)

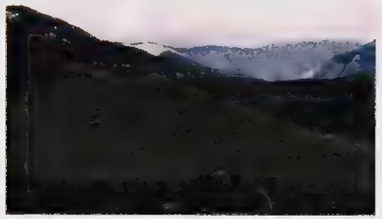
Land System(s): 4M4

Mean Preference Rating: 3.19
Preference Class: 3

(92)

Land System(s): 4L1, 4L2, 4L3

Mean Preference Rating: 3.19
Preference Class: 3



(27)

Land System(s): 6M2

Mean Preference Rating: 3.15
Preference Class: 3

63

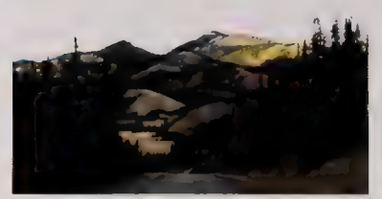
Land System(s): 6X1

Mean Preference Rating: 2.85
Preference Class: 2

(61)

Land System(s): 3G5

Mean Preference Rating: 2.84
Preference Class: 2



(72)

Land System(s): 6X6, 6X7

Mean Preference Rating: 2.47
Preference Class: 2

(30)

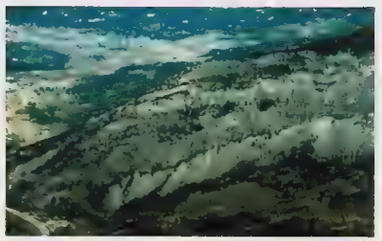
Land System(s): 3G1, 3G2, 3G4, 4G1, 4G2, 4G3

Mean Preference Rating: 3.10
Preference Class: 3

(12)

Land System(s): 4MR2

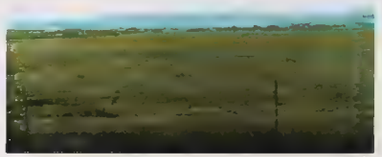
Mean Preference Rating: 3.07
Preference Class: 3



(18)

Land System(s): 5XR1

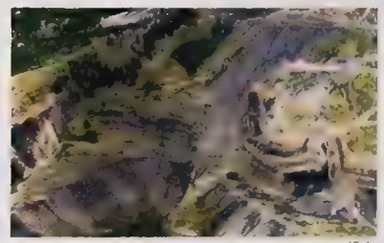
Mean Preference Rating: 3.03
Preference Class: 3



(20)

Land System(s): 3G3

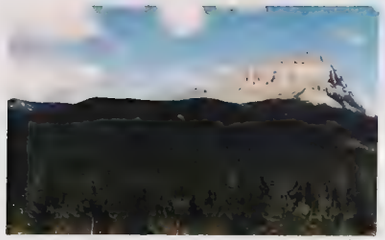
Mean Preference Rating: 2.18
Preference Class: 2



(54)

Land System(s): 6D1

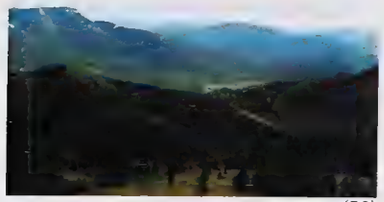
Mean Preference Rating: 1.79
Preference Class: 1



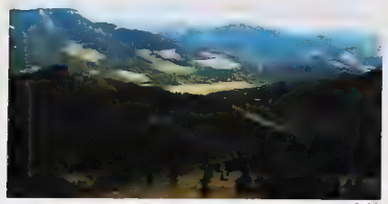
Mean Preference Value: 4.51 (53)

Mean Preference Value: 3.02 (22)

Preference Rating Reduction =33%

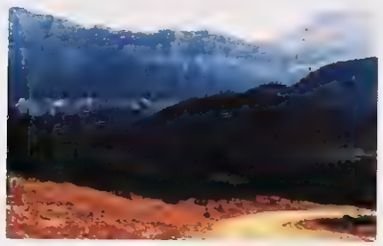


Mean Preference Value: 4.15 (50)



Mean Preference Value: 3.09 (90)

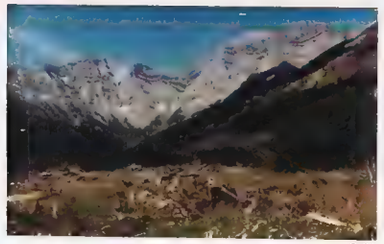
Preference Rating Reduction =26%



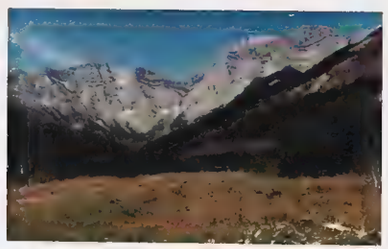
Mean Preference Value: 3.53 (4)

Mean Preference Value: 2.42 (81)

Preference Rating Reduction =31%



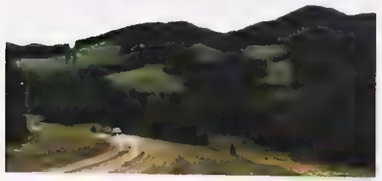
Mean Preference Value: 2.13 (36)



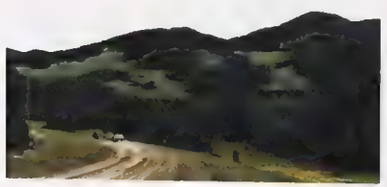
Mean Preference Value 3.16 (76)

The elimination of slash piles and logging debris in the foreground of this photograph resulted in a much higher visual preference rating.

Preference Rating Increase =33%



Mean Preference Value: 2.35 (38)



Mean Preference Value: 2.88 (78)

The removal of the straight cut line and the slight alteration in cut pattern resulted in a higher visual preference rating.

Preference Rating Increase =18%

Mean Preference Value 4.00 (11)

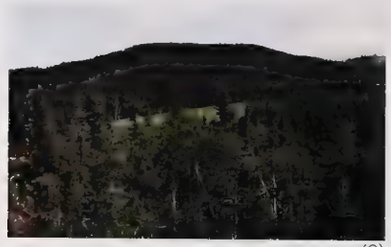
Mean Preference Value: 2.76 (62)

Preference Rating Reduction =31%

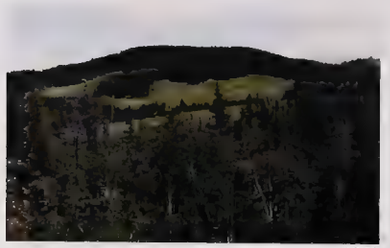
Mean Preference Value 3.75 (31)

Mean Preference Value: 2.49 (70)

Preference Rating Reduction =34%



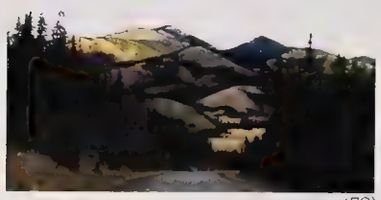
Mean Preference Value: 3.85 (3)



Mean Preference Value: 3.13 (80)

Preference Rating Reduction =19%

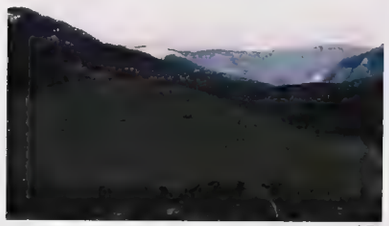
Mean Preference Value: 3.62 (34)



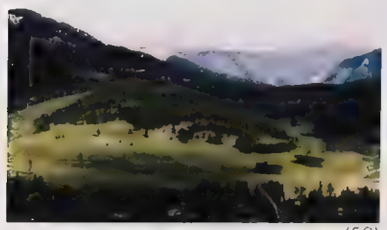
Mean Preference Value 2.47 (72)

Photograph #34 is a computer manipulation of photograph #72 which represents the natural landscape (no harvest has been done).

Preference Rating Reduction =32%



Mean Preference Value 3.15 (27)

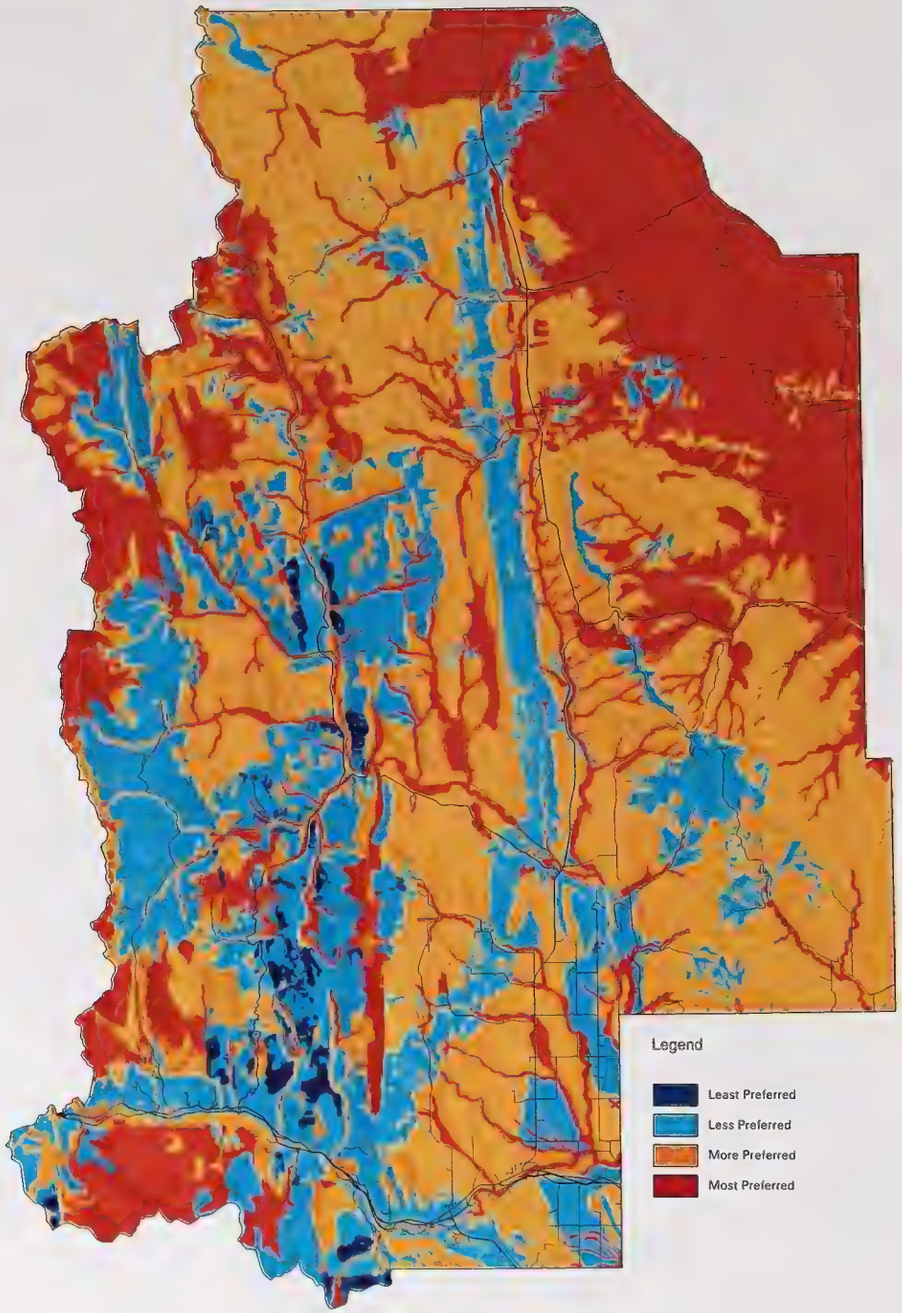


Mean Preference Value 3.46 (58)

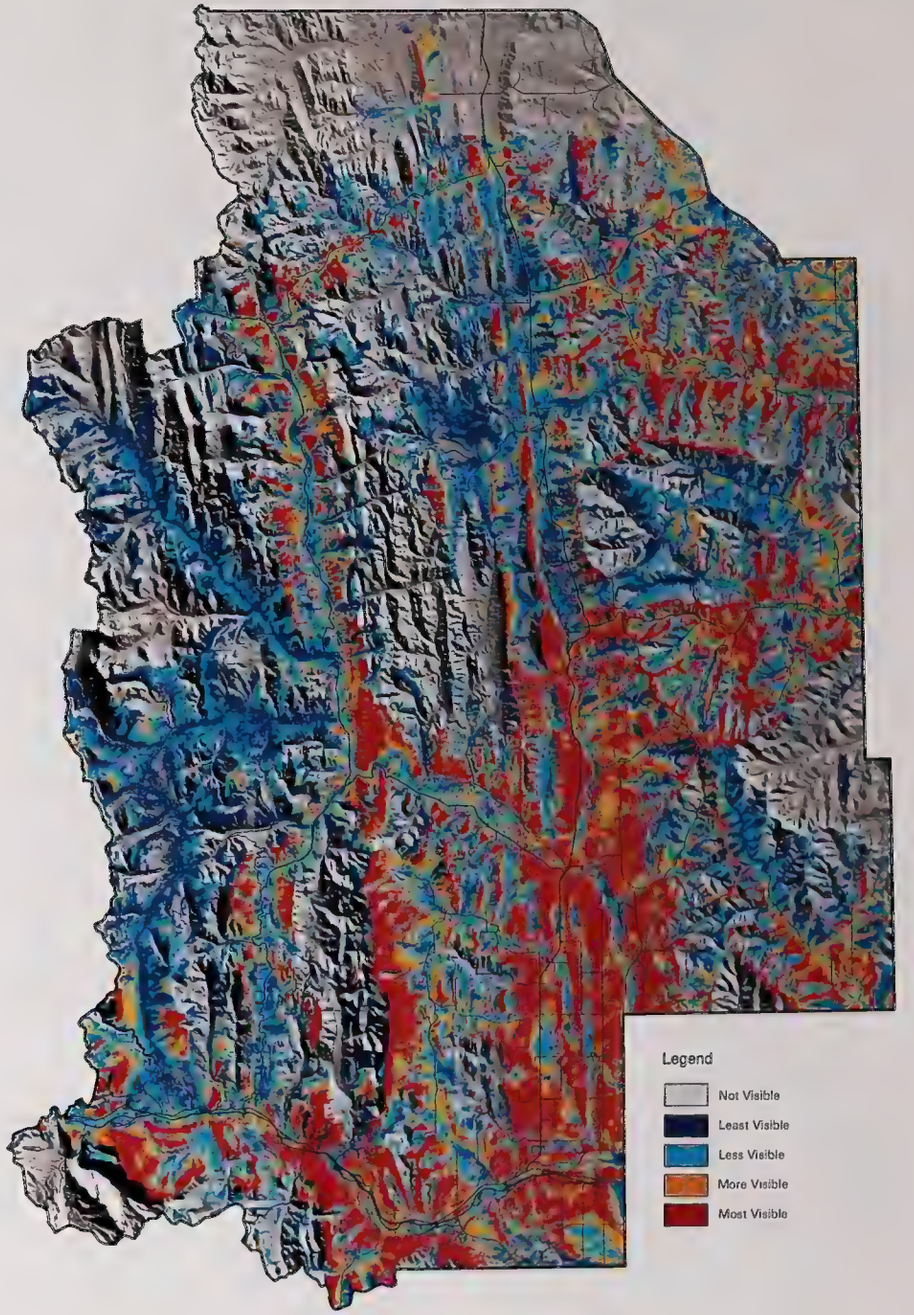
Photograph #58 represents the existing condition in which a very large area (approximately 900 hectares) was cut in a curvilinear pattern. In this instance the cut area was slightly preferred over the forested slope.

Preference Rating Increase = 9%

Existing Visual Preference



Visibility



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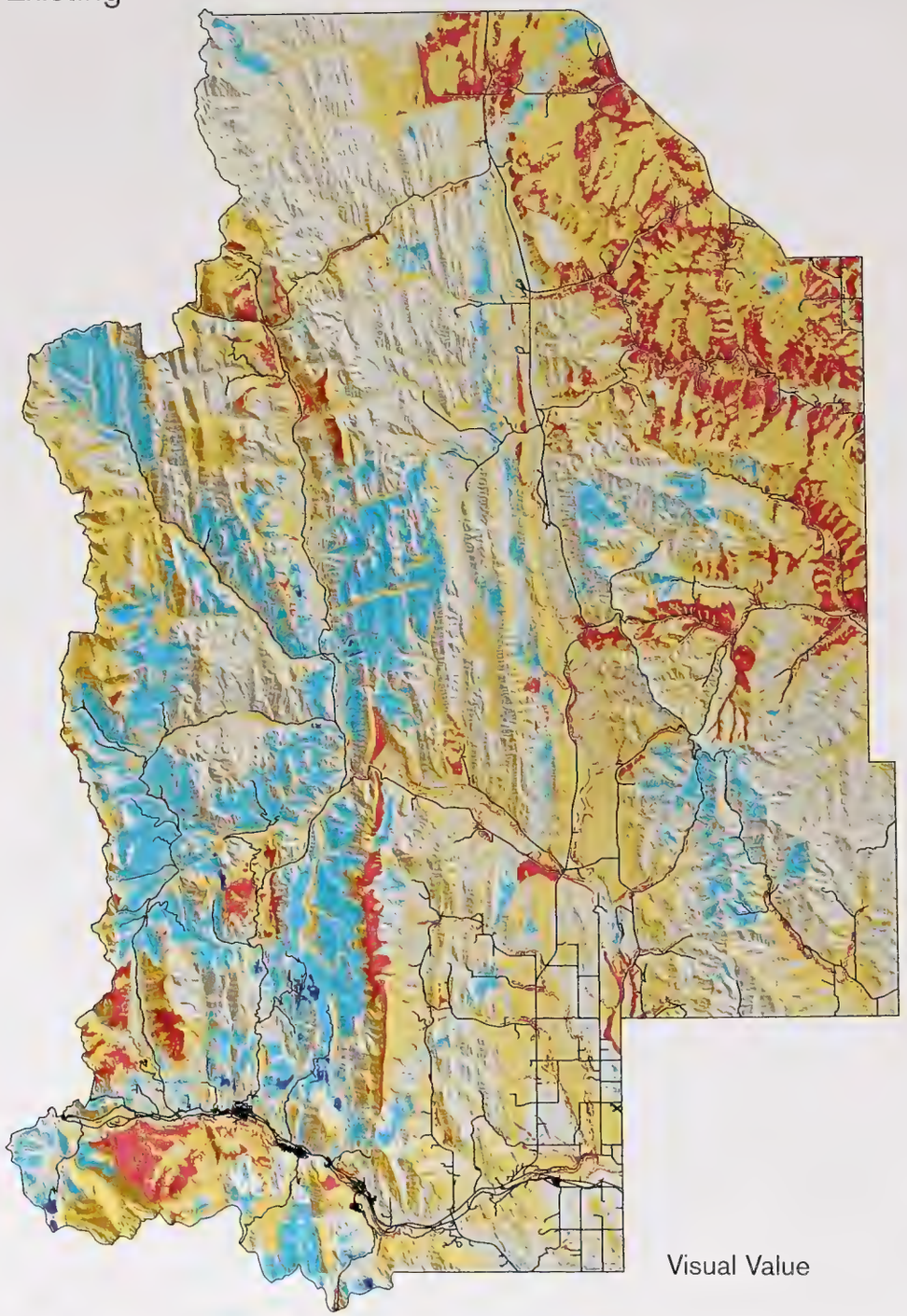
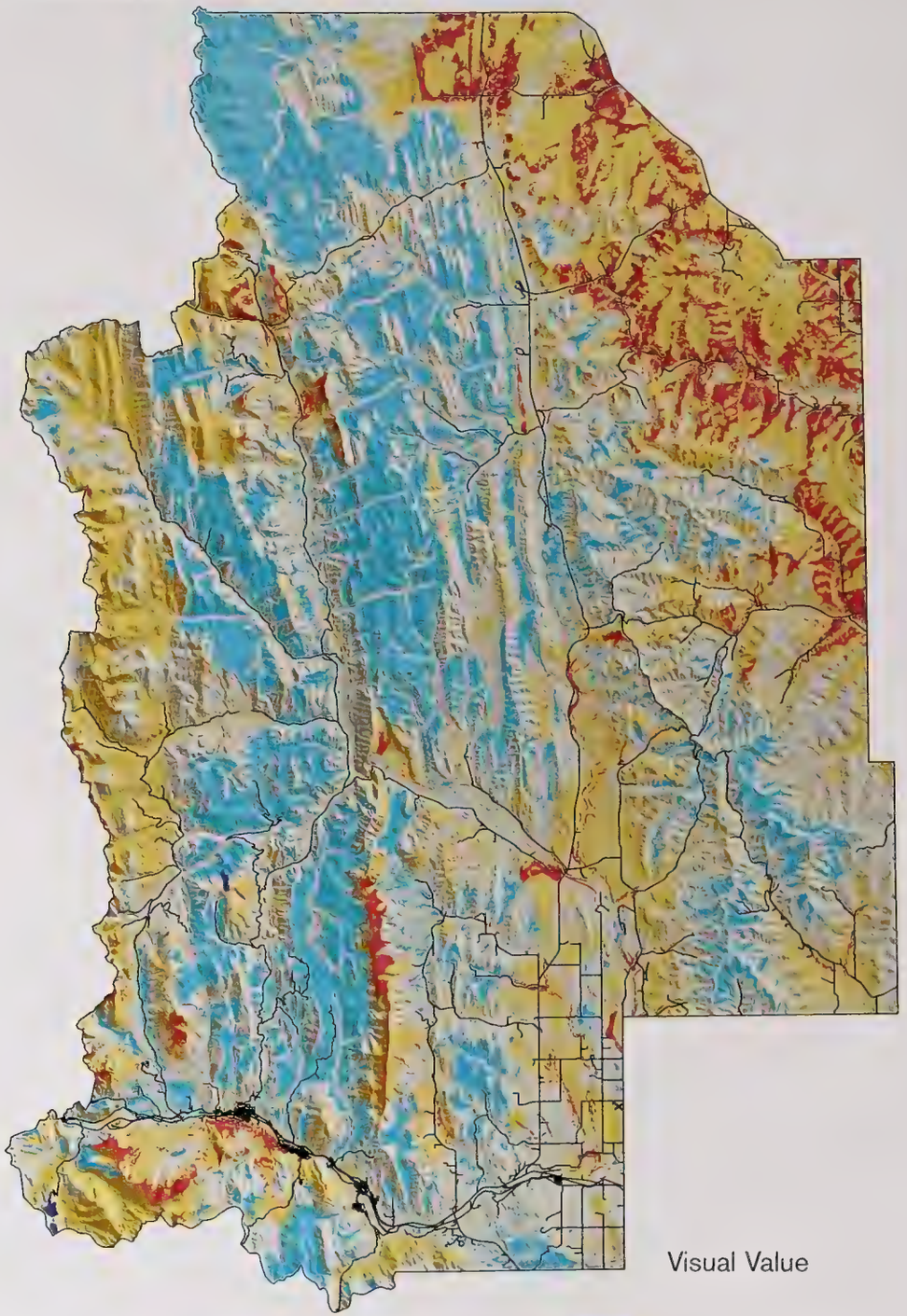


Visual Value

Lowest Lower Moderate Higher Highest

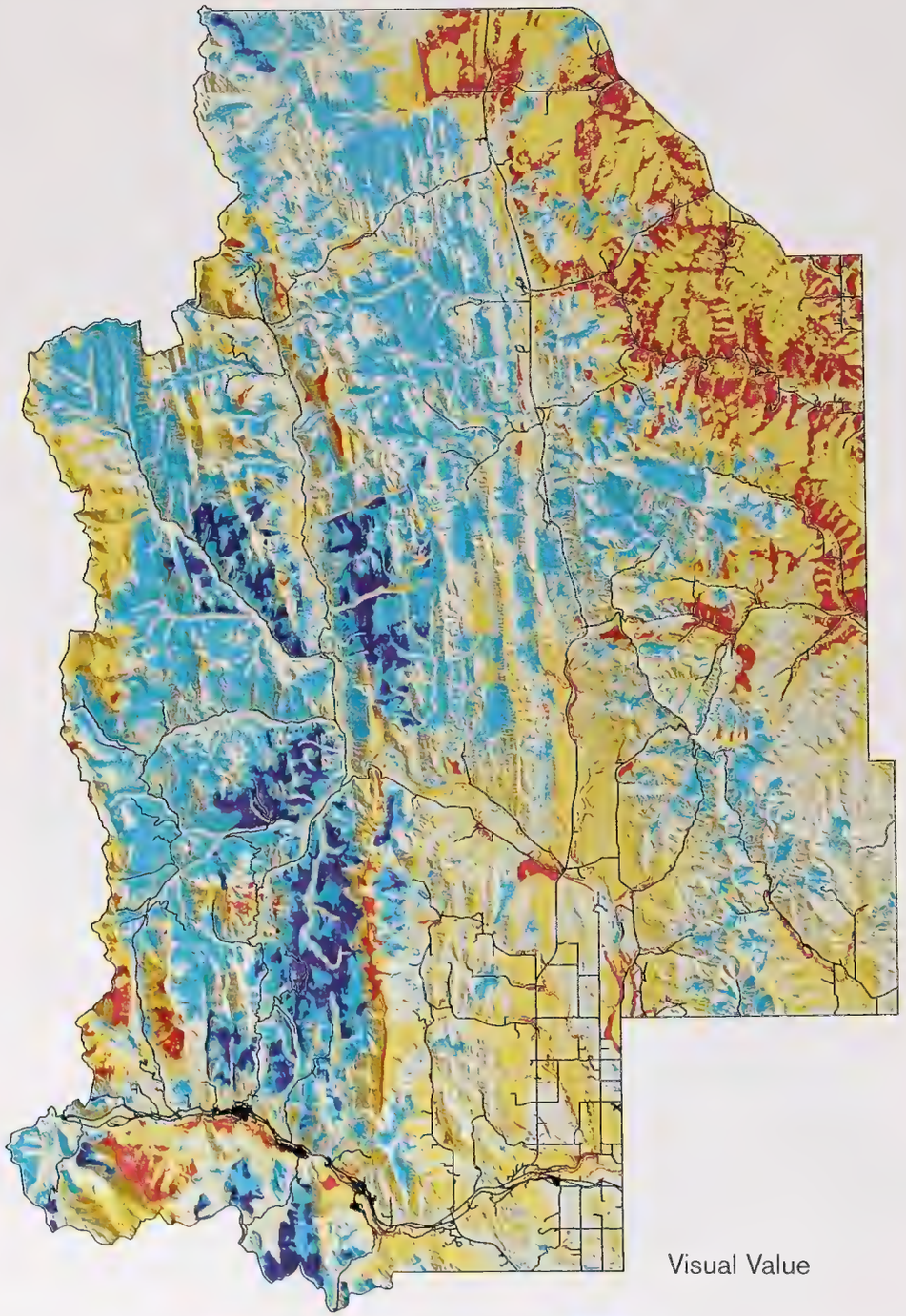
Disturbance



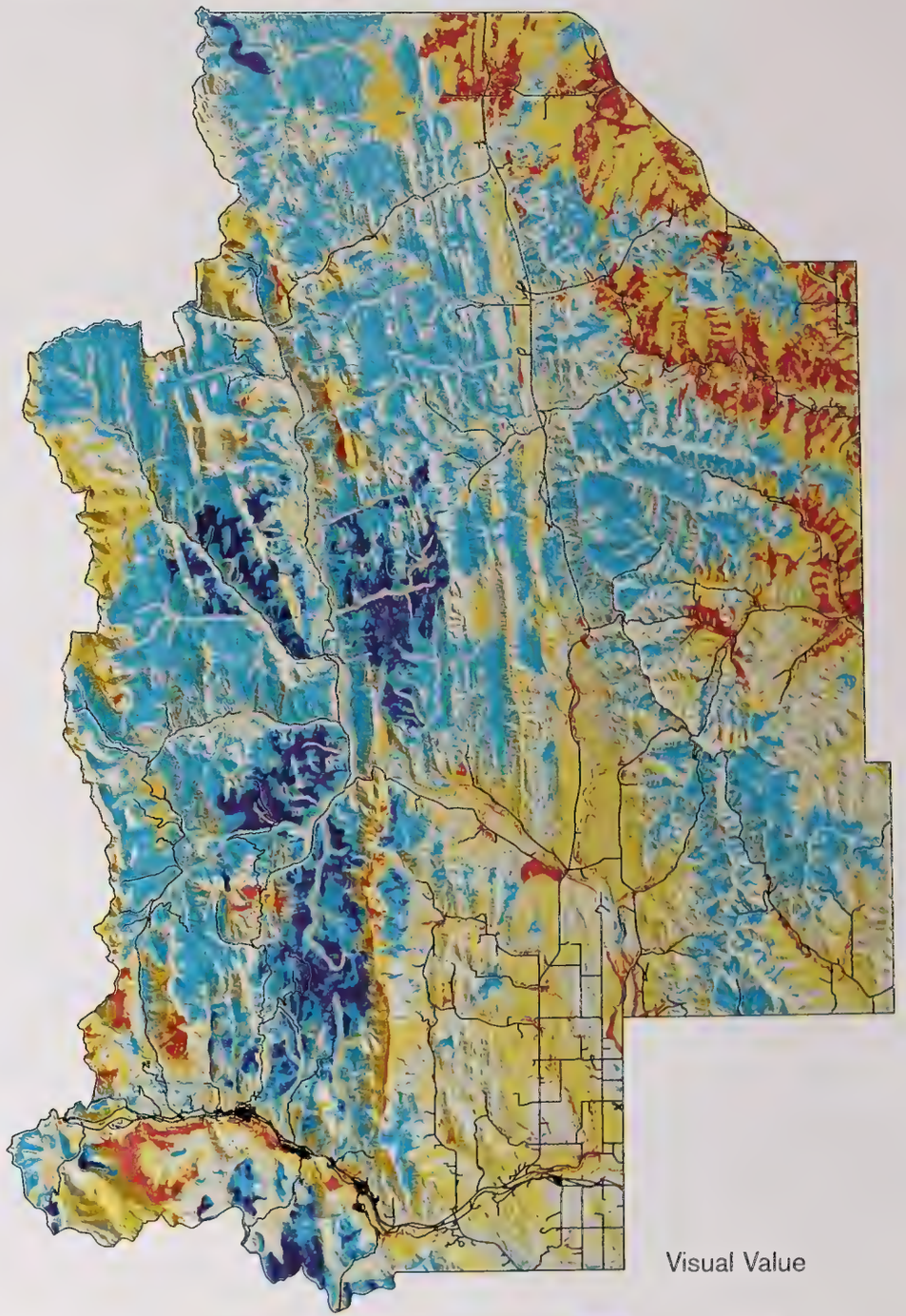
Visual Value

Lowest Lower Moderate Higher Highest

Trend 20



Trend 50



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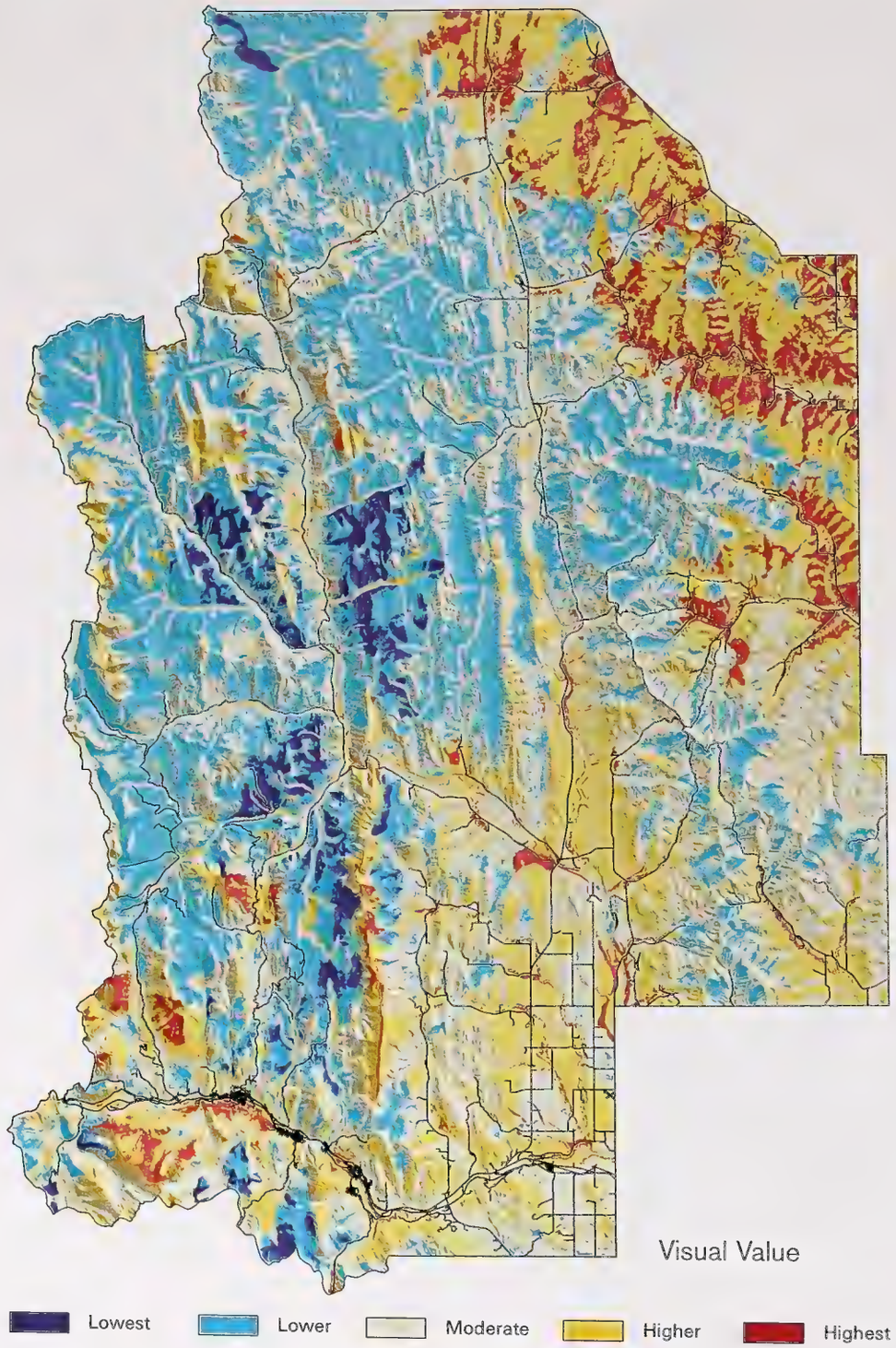

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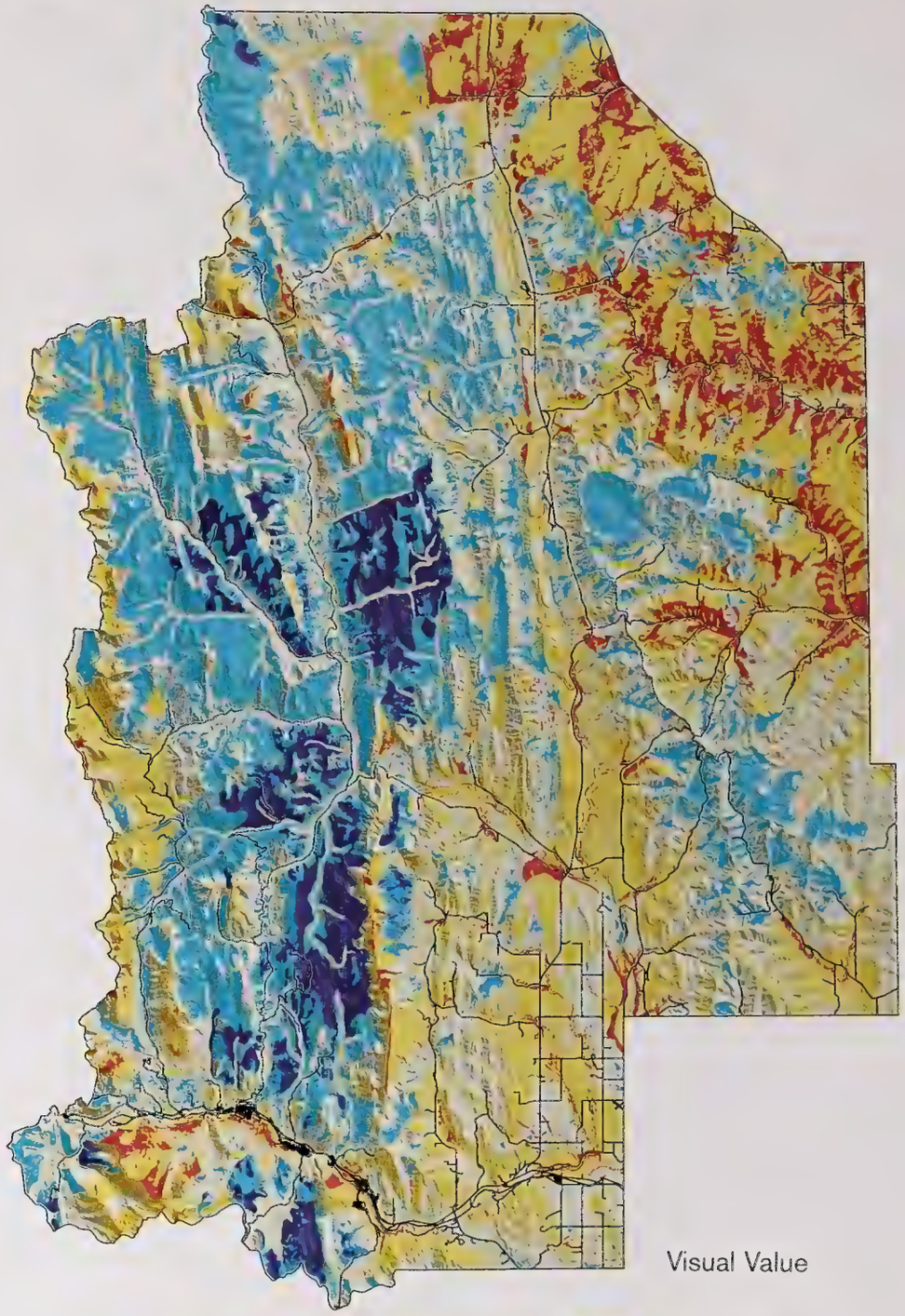
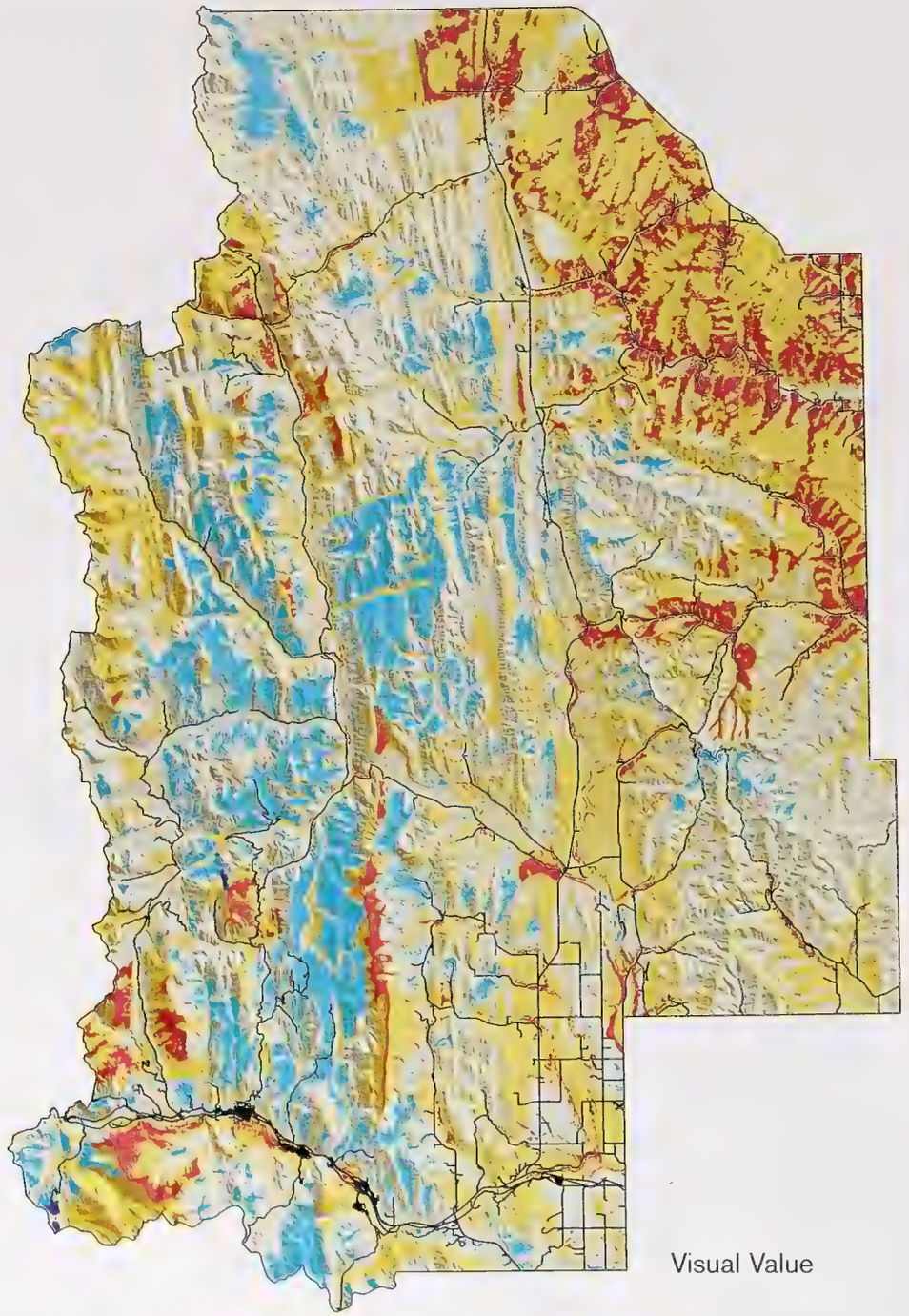


Preservation 20



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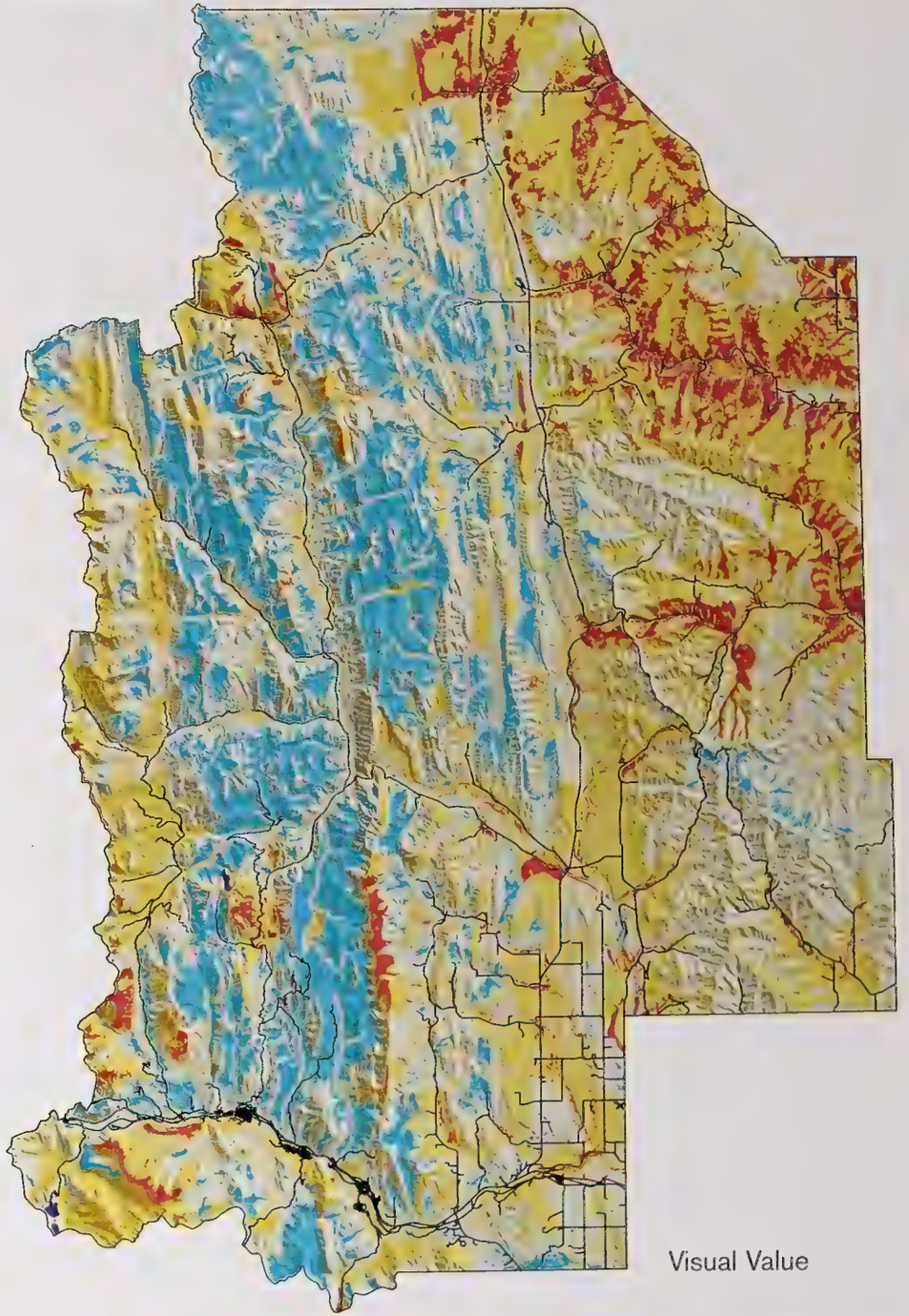
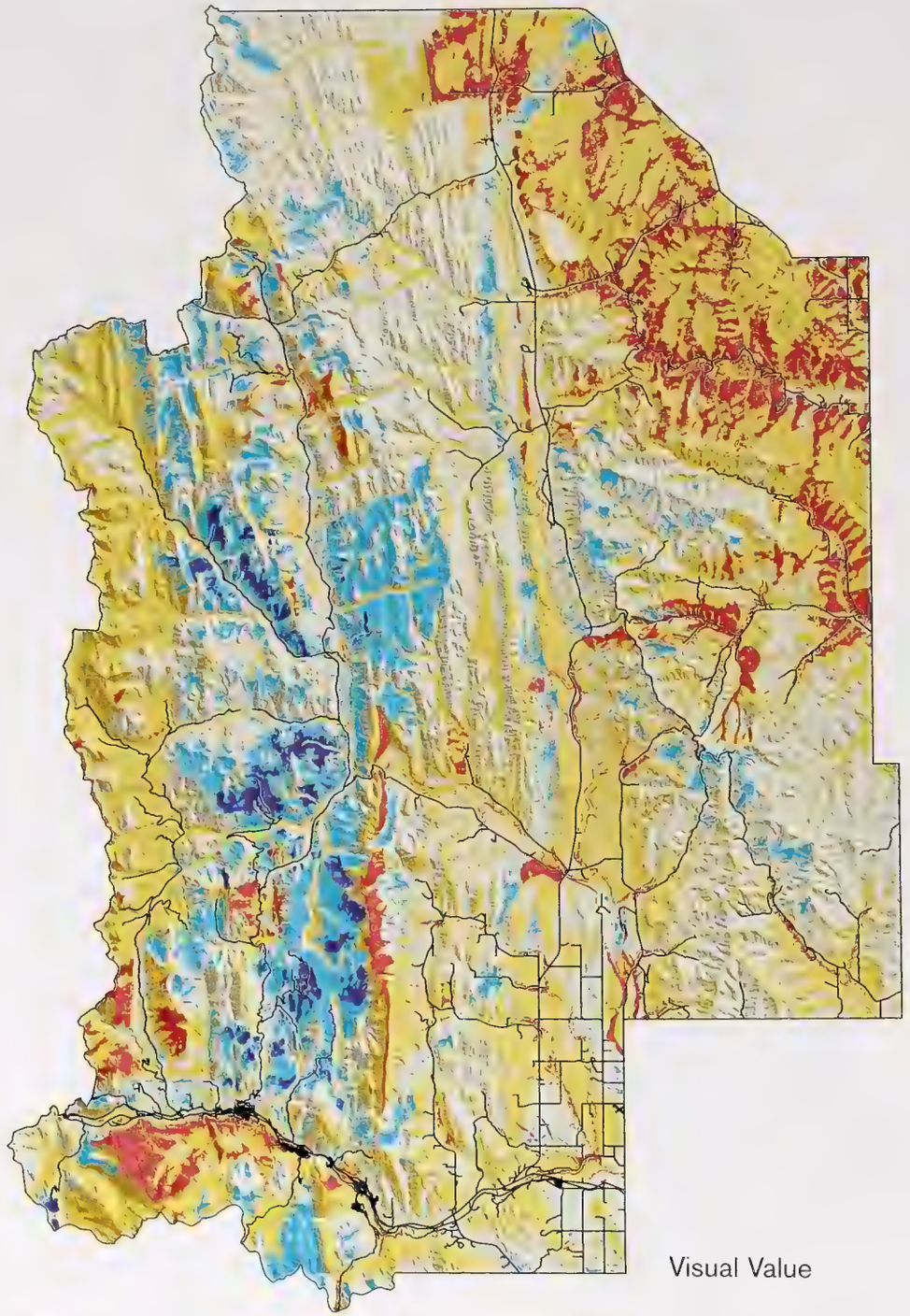


Recreation 20



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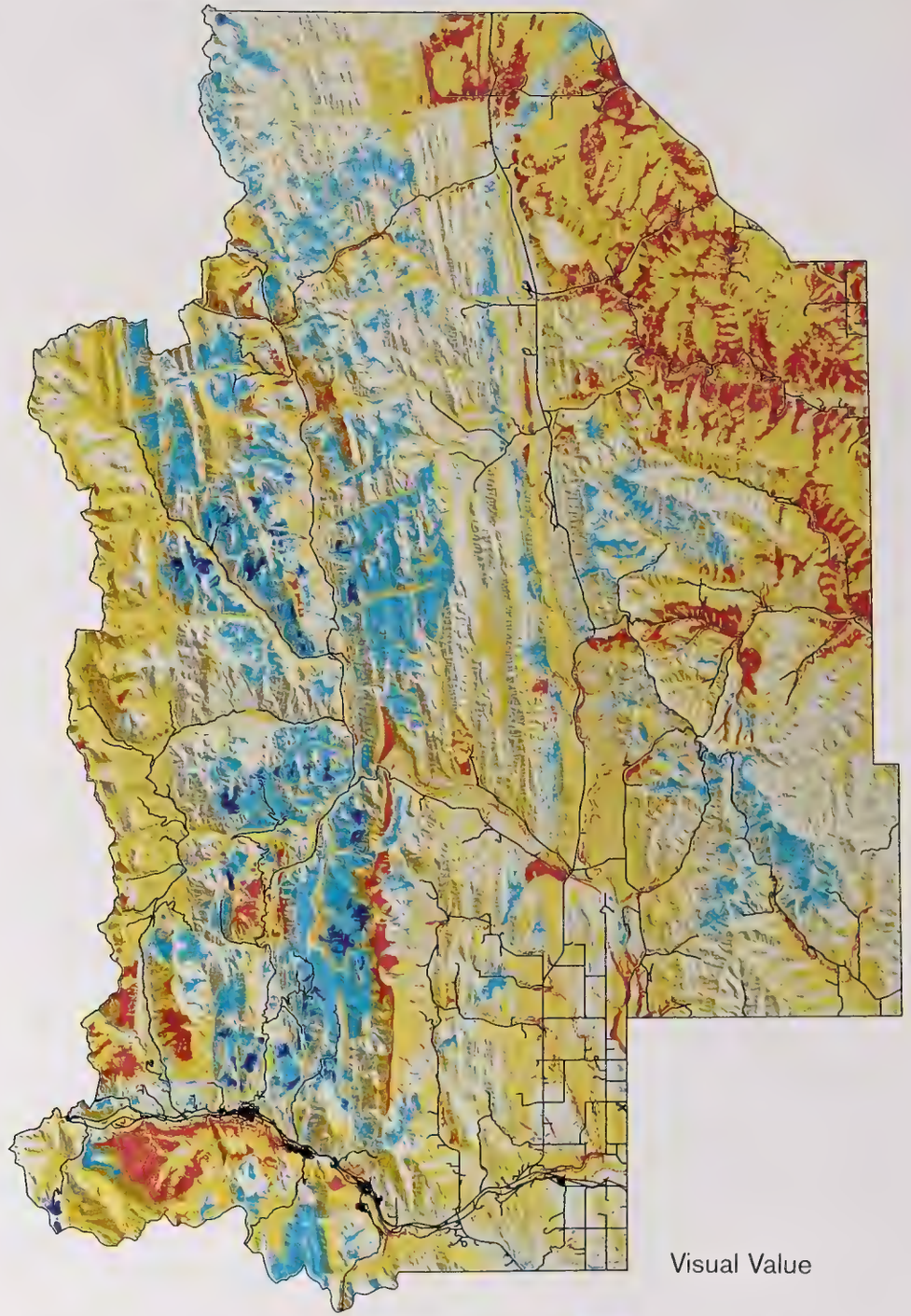

5. Conclusions and Recommendations

The Southern Rockies Landscape Planning Pilot Study has been a comprehensive applied research initiative directed towards ensuring sustainable environmental management of Alberta's natural resources. It considers the multiple and often conflicting demands placed on the regional landscape by evaluating the impacts to a broad range of resource values of various land uses and future scenarios.

The project has tested a framework for integrated planning that organizes the required data and modelling that is needed to support informed decision–making. It has also assembled a suite of computerized simulation models that are relevant to the key issues facing resource managers. These tools and their organizing framework may be used to provide decision makers, the public, government and other stakeholders with the information needed to judge the impacts of proposals to alter the land. It has striven to make technical information highly visual and accessible in order to facilitate meaningful public and stakeholder involvement.

Regional landscapes everywhere are changing rapidly, often with serious and unforeseen impacts. Government and others involved in land management need to know the ecological and socio–economic impacts of change. The processes and models developed during the project are intended to make explicit the impacts of both action and inaction, thereby contributing to informed decision–making. The project also provides a pragmatic method for cumulative impact assessment as it allows consideration of individual projects within a broad landscape context and considers the impacts of land uses on a wide range of values over long periods of time. The methods developed in the study have potential application in many areas throughout the province.

The project was undertaken as a pilot study in order to identify the strengths and weaknesses of both the approach and the various models that were assembled and constructed. The general approach and most of the detailed models have proven to be useful and directly applicable to regional landscape planning.

5.1. THE UTILITY OF THE APPROACH AND PROJECT FRAMEWORK

Landscape solutions are required at a broad scale in order to balance the land pattern requirements of multiple users. In order to maximize and protect the range of benefits that landscapes provide, comprehensive integrated planning is required. Such planning is a complex, multi–faceted and often costly activity. In the interests of economy and practicality, planning tasks must be organized so they are in direct response to the criteria that will be used to judge the performance of the landscape and the degree to which it meets societal objectives.

The general project approach of taking a regional landscape view with a long–term perspective is extremely important. Many processes, such as flows of fire, water and species, occur over very broad areas and long temporal periods and must be addressed at broad scales. The project has, therefore, focused on the landscape and regional scales.

The utilization of a framework for organizing the activities and required models of the project has also proved its utility (refer to Figure 1, page 5). The range of modelling activities, while broad, did cover the likely areas of concern to decision makers, as well as others, with an interest in the protection of the resource base. While the required models will likely require adjustment if applied to another area, the project framework will remain a useful organizing structure and process for determining specific planning methodology.

5.2. HIERARCHICAL LANDSCAPE PLANNING SCALES

A nested hierarchy of planning scales was utilized in the project. While the regional analysis has been the focus of much of the study, landscape management units, watershed sub basins, landscape compartments and ecosite phases have also been utilized. This multi–scale approach is necessary in order to capture all processes of interest.

Regional scale analysis, while important, does not capture the variation present in landscapes and cannot be used in isolation. Landscape management units (or landscapes) have proven to be an important spatial unit for both the analysis of existing conditions and the specification of future changes. Sub basins are a requirement when analyzing fluvial processes such as stream discharge. Landscape compartments, which are delineated by combining landscape management units and sub basins, are a new concept to arise out of the project. These units will likely be used for operational planning and access management. Ecosite phase was used as the common spatial vocabulary of all alternative futures. The use of a single map of ecosite phase to describe any point in time, which then can be directly input into most of the impact models, is effective and efficient.

5.3. LANDSCAPE CHARACTERIZATION AND ASSESSMENT

Detailed disturbance and pattern analysis at both the landscape and regional scales has provided a baseline description of the existing conditions. This landscape characterization can be used in several ways. First, to provide a benchmark to determine the degree of divergence from the current conditions those future scenarios may represent. Second, the characterization should be used to provide planning specifications or land pattern objectives that are specific to individual landscapes.

The assessment provides an understanding of the landscape pattern and structure, its disturbance regime and successional trajectories, its use and function as well as major landscape resource flows such as fire, water and species. It is a fundamental precursor to defining the desired future forest.

5.4. SCENARIO PLANNING

The project has assembled a wide range of scenarios, which assume radically different management strategies (i.e., the Fibre Scenario and the Preservation Scenario). In a real planning exercise, a more balanced scenario would be pursued in an integrative and recursive process. While it is not expected that extreme scenarios would be the focus of an actual planning project, they are useful for determining areas of coincidence or likely conflict with other values. The Disturbance Scenario is one that would be important to demonstrate in most of the east slopes landscapes. The public should be aware of the potential for the occurrence of very large fire events.

5.5. IMPACT AND EVALUATION MODELS

The evaluation and impact models were chosen to represent the likely set of criteria that decision makers and resource managers are interested in. It is expected that a planning work group would be formed

in a real planning exercise. The group may choose a different set of impact and evaluation models. However, it is likely that most of the set used in the pilot would be included.

Single species models may vary by landscape, but should be chosen to represent specific landscape conditions and characteristics such as large contiguous patches, old growth and riparian woodlands. There is little point in modelling species that are not likely to respond significantly to change. For example, mink are not greatly affected by any alternative that follows existing ground rules and probably are not worth modelling in the future. Elk, while very important in the area, also show little response to harvesting, and the benefits of modelling are limited.

Grizzly bears are wary, multi–landscape carnivores that are sensitive to human interaction and fragmentation of the landscape by access. The map of effective daily foraging value is one of the most useful created in the pilot project, particularly as it relates to wildlife movement and broad regional corridors.

Other aspects of the biodiversity modelling included: avian diversity, ecosite phase diversity, unique, rare and sensitive elements and generalized landscape pattern. Avian diversity appeared to respond to widespread landscape vegetation change and should be included in future modelling. Avian diversity showed some correlation with ecosite phase diversity and may, with further correlation, provide a useful measure for those areas where avian data is sparse. Unique, rare and sensitive species locations are important and the method used gives a coarse indication of the impacts. It provides managers with an early warning system that then requires site specific investigations.

The generalized landscape pattern analysis provides a useful indication of the degree of protection afforded some of the "indispensable patterns" in the landscape (large patches, naturally vegetated streamside). It also clearly indicates the degree of fragmentation at the broad scale.

Fire modelling will become increasingly important and the degree of modelling presented here should represent a minimum required of all FMPs and GDPs. The utility of the head fire intensity model is that it spatially indicates those areas where intervention (fuel modification, stand conversion, anchor points creation) would be most usefully employed.

The Interior Watershed Assessment Procedure (IWAP) modelling indicates those areas potentially at risk to watershed degradation. In addition to the IWAP, peak flows need to be re–examined. All Annual Operating Plans and General Development Plans must be evaluated for their impact on watercourses and stream discharge. The WRENNS modelling carried out during the pilot appears to be a useful method and should be used routinely to check the effect of harvesting, particularly on small basins.

Timber supply modelling must be spatial and should be able to treat stands on multiple occasions (e.g., partial cuts in multiple entries). Grazing supply should also be included in the analysis with a provision for assessment of aspen and willow encroachment.

The visual assessment model is an important component of the study. The region is highly valued and deserves careful and thoughtful management of the visual resource. The tools for visualizing potential landscape are extremely powerful and, in addition to the illustrations in this report, panoramas, fly throughs or ground level photo realistic simulations are available. Visualization tools encourage meaningful public and stakeholder understanding and involvement.

5.6. MINIMUM DATA REQUIREMENTS

The data volume for the project was very large. Costs of data acquisition on similar projects are typically in the order of 50% to 70% of the total project costs. Therefore, every effort must be made to reduce data requirements to that needed to support the models necessary or desirable for decision–making. The project framework is used to rationalize and reduce data requirements.

5.7. GAPS IN THE PILOT PROJECT

The study was a pilot project in recognition of the fact that problems would be encountered and gaps would be identified. Perhaps the most fundamental of the study problems was the quality of the original Alberta Vegetation Inventory (AVI) data. Problem areas within the AVI are being replaced with new inventory data.

Timber growth and yield was also problematic. Field sampling of ecosite phase plots was carried out, but due to the misclassification of some sites relating to poor AVI, correlation between ecosite phase and yield was difficult to establish. Yield curves for the area were produced, but are subject to revision.

The use of ecosite phase did cause some problems for the grazing supply model as it did not provide enough emphasis on the grassland component of the understory. In fact, plant community components are not actively considered in ecosite phase classification. This was also problematic for food value interpretations in the grizzly model. In addition, assigning of shrub browse value for moose required an equivalency between forest cover and ecosite phase in order to identify areas of potential foraging value.

The Disturbance analysis was based largely on original data in the AVI. Field sampling was carried out only on a portion of the study area. While charcoal studies and detailed field work would contribute to a more thorough understanding of disturbance regimes in the area, it is unlikely that such data would be available for an acceptable cost.

The study area contains some of the most important fish bearing streams in the province. Unfortunately, no fish species were modelled in the pilot project. Modifications to fisheries habitat brought about by changes in stream flow were also ignored. Correlation between stream morphology and stream discharge was not possible given the current stream inventory and state of knowledge. Therefore, indirect assessment of the impact of land use change on fisheries was made by reviewing the watershed assessment score cards as well as the WRENNS modelling of stream discharge.

It was anticipated early in the project that the complete suite of terrestrial vertebrates would be related to ecosite phase in order to establish a species richness map based on habitat association. However, habitat associations were not available for all species. Avian diversity was assessed (Shank, 1998) using field sampling of forest cover types and an equivalency to ecosite phase.

Type, intensity and extent of human use was difficult to obtain and thus was a significant gap in the project. Only campsites, random campsites and known trails were utilized. No actual human use surveys were considered. Access mapping is undifferentiated between cutlines, hiking trails and minor logging roads.

The sampling for visual preference needs to include various silvicultural treatments including partial cuts. In addition, while fires did not appear to reduce visual preference for an area, only small fires were sampled and very large events should also be included in future sample sets. It is likely that the degree of visual tolerance of fires will drop as size of event increases.

With the exception of the economic modelling, all analyses was restricted to the study area. Cross boundary flows of materials, species, fire, water and people also need to be considered in future planning of the area. In future, it is suggested that cross boundary issues be addressed, in part, by modelling a larger area than the area of interest and subsetting model results.

5.8. USING THE TOOLS IN A PLANNING PROCESS

The pilot project intent is to develop methods and tools that will be used for planning. It is suggested that the project general framework be used as indicated in Chapter I to first, establish the context for the work, secondly, to identify the methodology and thirdly, to carry out the study.

5.8.1. THE DESIRED FUTURE FOREST AND LAND PATTERN OBJECTIVES

The definition of the future forest is a critical step in the landscape planning process. The results of the landscape assessment, which include running all of the evaluation models on the existing landscape, provides an understanding of the functioning of the landscape and its potential for change. It is suggested that this future be described in terms of land pattern objectives. These land pattern objectives need to include statements on resource flows and other measurable aspects of the desired future forest.

In order to integrate multi–sector interests and requirements within the planning process, land pattern objectives are required for each major area of concern (fire management, grazing, recreation, biodiversity, wildlife habitat, forestry, etc.). These objectives need to be developed at two scales; namely the regional scale (the entire study area) and the Landscape Management Unit (LMU) scales. Objectives may also be developed at a more operational level for individual landscape compartments. The pattern objectives are used to identify where conflicts and areas of coincidence of objectives are located and to identify a spatial solution to the multi–sector requirements. The pattern objectives are specified in a narrative description, which is interpreted spatially during the design of the area. An example of a potential set of regional pattern objectives is found in Appendix 1. These are meant to be illustrative only and they have not been developed in an actual planning exercise.

Not all planning objectives will relate to the future state of the forest itself. Some objectives will relate to the flows of products, how they will be used and the effects that they cause (e.g., jobs, etc.).

5.8.2. RELATIONSHIP TO OPERATIONAL PLANNING

Broad scale landscape planning should inform operational planning. Annual operating plans and general development plans should implement the land pattern objectives, which are determined for both the regional and landscape scales. The set of impact models that are run at the broad scale should be utilized at the finer scale as well. WRENNS modelling should be required when the level of cut in a basin exceeds 10%. Visualization of the cutblocks prior to plan approval should be required on all sites that are visible from important viewpoints or roads.

Distribution of access and disturbance is one of the key issues of operational planning. One possibility that might be considered in future planning is much more aggregated harvesting with both access and harvesting occurring within a landscape compartment or small group of compartments at any one time. Harvesting within those areas may be more intensive and volume may be removed more quickly than is presently the case. Size of cutblock as well as regeneration requirements may be landscape management unit specific. Access may be intensive for the period of harvest. Following harvest and successful silvicultural treatments, the roadways could be removed. In this way, the distribution of human disturbance would be more focused and less fragmenting. Ecosite phase could be used to determine acceptable silvicultural treatments.

5.9. THE NEED FOR MONITORING AND ADAPTIVE MANAGEMENT

The uncertain nature of many of the impacts of forestry operations requires that a prudent approach to management and implementation be adopted. Criteria of assessment and their thresholds need to be in place prior to plan development and implementation. These must be measurable criteria. Monitoring of the implementation of the plan is required. Assumptions about impacts need to be reviewed and refined in light of ongoing monitoring. Benchmarks in the form of non–disturbed areas are required in order to compare the impacts of intervention.

While recognizing the importance of monitoring, this project has identified neither the range of issues or the frequency of monitoring that will be required. A comprehensive set of criteria is required and should include those identified as necessary for regional cumulative effects.

Adaptive management is required whereby expected impacts are monitored and future actions are reassessed in light of changing values, new understanding and evolving technology. A formal time limit for management review should be identified.

5.10. THE NEED FOR BROAD SCALE INTERDISCIPLINARY INVESTIGATIONS

The Southern Rockies Study has clearly demonstrated the need for adopting a broad scale approach to the planning of regional landscapes. Rapidly changing landscapes require a comprehensive management strategy that addresses, simultaneously, the needs of production, recreation and conservation of valued resources.

Environments have a far greater chance to sustainably satisfy societal demands if planning recognizes that flows of fire, water, materials and species cross jurisdictional boundaries. While management strategies may be different on Crown lands than on private, it is in everyone's interest to understand and respond to broader landscape processes and requirements. Management of landscapes requires a cross–disciplinary and integrative approach. Landscapes are mosaics of interacting elements and land uses and, as such, must be viewed and managed comprehensively with full regard for the processes operating within and between them.

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Appendix 1
Example of Potential Land Pattern Objectives

REGIONAL LAND PATTERN OBJECTIVES

Broad regional land pattern objectives are required in order to ensure that overall objectives are met. The following objectives are grouped into Ecological, Cultural and Resource Utilization categories. These are meant to be illustrative only and they have not been developed in an actual planning exercise.

ECOLOGICAL

It is the general hypothesis of the study that most of the important ecological processes and attributes of the region will be conserved if a set of key spatial patterns of the region and its constituent landscapes are maintained. Many landscape ecologists and planners believe that these land patterns will protect most, but not all, of the important ecological attributes and functions of an area. These patterns are described as "indispensable" (Forman, 1995) as, in addition to capturing under their spatial umbrella many other important ecological attributes, they protect the most important components and provide a function that cannot be substituted. Examples of indispensable patterns are:

- large patches of contiguous natural vegetation
- connectivity between these large patches
- connectivity of the background matrix of vegetation in which modifications such as harvest areas resides. Contiguous pixels are considered connected.
- well vegetated stream corridors
- stepping stones and corridors of natural vegetation across disturbed areas

While these indispensable patterns apply in most landscapes, they are particularly applicable in the Southern Rockies study area. This area has historically had very large contiguous patches of natural vegetation as a result of both the underlying physiography and the large fire disturbance regime as well as its settlement and development history. The background matrix has historically been well connected coniferous forest cover in the western portion of the study area while the eastern portion has, for the most part, been well connected native grasslands containing patches of both deciduous and coniferous forests. Previous analysis has confirmed that disturbances tended to be aggregated in large patches leaving other, very large areas undisturbed for long periods of time. Riparian areas have been, and for the most part still are, very well vegetated. The map of landscape pattern for the existing conditions clearly indicates that large patches and well vegetated corridors still persist.

It must be stressed that maintenance of these patterns does not preclude management and resource extraction. Many of these patterns will not be static but rather, will be part of a "shifting mosaic". For example, large patches of unroaded natural vegetation may exist in some compartments for many years, while harvesting or other operations are concentrated elsewhere. At a suitable point in time, operations will shift to the unroaded compartments while ceasing in others. The shift in operations needs to be accompanied by reclamation of roads and access management. In this way, essential patterns are maintained and a disturbance regime that more approximates natural conditions is established.

In addition to these indispensable patterns, it is important to maintain "outliers" of natural vegetation (which may include rare and unique elements) throughout areas which have been heavily disturbed. This would have occurred in natural fire regimes as fire "skips" and in more fire resistant riparian areas. Strategic points or other patterns in the landscape must also be considered in the planning process.

The following three categories of general patterns (i.e., indispensable patterns, aggregated land uses and strategic, rare or unique places in the landscape) should be maintained and protected. These may need to be supplemented by the specific pattern objectives identified in the sections that follow. While some may be permanent deletions from the land base for timber purposes, most are not.

INDISPENSABLE PATTERNS

- Provide at least 6 large (over 10,000 ha where possible but not less than 5,000 ha) patches of contiguous natural vegetation at all times during the rotation. Contiguous natural vegetation (which includes cutblocks over 20 years old) is fragmented by perennial and annual crops, cutblocks less than 20 years old, all non vegetated lands and roads greater than one lane. Streams or naturally vegetated meadows, shrublands or grasslands do NOT fragment it. Patch representation should include two from the Montane (e.g., one in each of the Whaleback and Porcupine Hills, one in the Parkland, two in the Subalpine (upper subalpine and lower subalpine) and one in Fescue Grasslands). Adjacent protected areas, old growth or any other deletions may be included in the area calculation of these patches. Other than currently protected or other timber land base deletions, these areas will be subject to harvest at some point. While the patches may shift in location, large patches must be maintained somewhere in the region at all times.

- Maintain connectivity between the large patches of natural vegetation. A corridor minimum width of 1 km should be maintained. The corridor vegetation may be managed, but species movement considerations are primary. Seasonal operational and harvest type limitations (e.g., partial cut) may be imposed. Vegetation sufficient to provide wildlife cover must be maintained in these areas. This minimum corridor width of 1 km represents a prudent dimension in order to retain long–term connectivity between patches. Maintenance of large patches is NOT sufficient.

- Maintain naturally vegetated corridors along all major streams and rivers. At a minimum, maintain the primary protection zone as identified in the stream friction buffer zone map. The map of primary and secondary stream influence zones identifies a variable width zone based upon stream order, slope and potential for erosion. For first order streams, the primary zone varies from 50 to 75 m either side of the stream. The zone decreases as slope steepness and soil erodibility decreases. Primary protection zones also decrease as stream order increases. Primary zones for fifth and greater order streams vary from 25 to 50 m. Secondary zones in first order streams may extend as far as 150 m in steeply sloping, highly erodible lands while secondary zones for fifth and greater order streams extend to a maximum of 75 m. Carefully controlled harvesting may occur within the primary zone corridor, but vegetative cover must be continually maintained. Vertical structure will be provided in this zone and should include tree, shrub and herbaceous/graminoid layers. Roads must be excluded from primary buffers with the exception of stream crossings, which should be minimized. Management of secondary stream buffer areas should consider corridor impact issues.

- Provide for small patches, stepping stones and corridors across heavily disturbed landscape compartments and patches (including cutblocks). At least 5 – 10% of disturbed areas (harvest blocks or prescribed burn areas) should be maintained in patches of unaltered natural vegetation. The 5 – 10% is in addition to silvicultural considerations such as partial cut percentage retention or snags and coarse woody debris. Many of these residual patches should be in patches large enough to have interior vegetation (120 m diameter minimum). The percentage of the block interior left in small islands which are not likely to be harvested in the second pass shall be withdrawn from the AAC calculation. It is recommended that residual islands be of such a size and area as to be feasible for harvest in the second pass and therefore reduce the impact on the AAC. The percentage of the interior of the block left in small islands may be reduced if the second pass residual contributes to within block connectivity by the retention of sizeable islands. (NOTE: the second pass must not be removed for approximately 60 years.) While some of these islands and corridors may blow down, they will contribute to the requirement to leave coarse woody debris in the area.

AGGREGATED LAND USES AND PRINCIPLES FOR PLACEMENT OF OUTLYING LAND USES

- Aggregate land uses in large patches or large groupings of nearly adjacent patches (e.g., harvesting may be aggregated by removing up to 50% of the volume from a small watershed while retaining islands and corridors across the harvested areas as well as substantial volumes that would not be removed for a long period of time (perhaps as long as 60 years). It is essentially a two–pass system of large blocks with considerable internal structure and with a very long leave time before removal of the residual volume. There will be some effect on the AAC for the area as some immature stands may be required to be harvested and some stand break up may occur as a result of longer rotations and longer leave times until the residual is cut. The size of the disturbance patches of natural vegetation currently existing in the Landscape Management Units will influence the actual size of the harvest entries. For example, in the Middle Ridges, the opening size is expected to be much larger than in the Porcupine Hills. While disturbance will be relatively aggregated in both (compared with current practices), it will be "patchier" and more dispersed in the Porcupine Hills.

- Some outliers of human disturbance (e.g., harvest blocks, campgrounds, well sites) may be considered although, wherever possible, they should lie close to the edges of the large patches of natural vegetation. The density of outlying land uses should be higher when closer to the main aggregation of the land use (e.g., harvest blocks may be aggregated in a single landscape compartment, but additional cutting may be considered throughout the region). The distribution of the blocks should increase in density closer to the main areas of harvest. The farther away from the main area of harvest, the more isolated and rare the blocks should be.

- Connectivity of large forested patches should be maintained or enhanced by provision/retention of small forested patches and corridors.

- Small patches of native grassland and forest should be distributed across areas of perennial and annual cropland. While most of this land is under private ownership, land owners should be encouraged to undertake these practices.

- Areas of Human Settlement/Development should be highly aggregated wherever possible. If required, smaller patches of development should be concentrated at the edges of forest reserve.

STRATEGIC PLACES IN THE LANDSCAPE (UNIQUE, RARE AND SPECIAL)

- Protect and buffer key wildlife corridors, wintering range, mineral licks, nesting sites/rookeries, nursery areas, calving and breeding areas, and wetlands.

- Protect and maintain at least one large patch (5,000 ha) of existing old growth forest in the subalpine (refer to monitoring section) and ensure contiguity of the patch between landscape management units. This is not considered a deletion and may be formed by portions of protected areas as well as areas of commercial forest production. While old growth should be maintained in the Upper Subalpine, it may shift in location. The rotation age in this zone should be at least 150 years. Variable age rotation is therefore necessary in the region. The upper subalpine currently contains a few large patches of old growth that is unique in the region.

- Protect places where flows are concentrated (major flux centres) (e.g., steep slopes, stream corridors, key intersections or passages in corridors, critical passes, etc.). Examples include: The Crowsnest Pass, The Livingstone Gap, Dead Man Pass, Race Horse Pass, North Fork Pass, Tornado pass, the grizzly corridor along the west side of the Livingstone Range, critical passage points across Highway 3 and the connection between the Porcupine Hills and the areas to the west. Flows to, from and through these areas must be maintained. Special access and harvesting methods may be required.

- Protect areas of highest avian biodiversity (mixedwood, deciduous and other areas identified in the avian biodiversity model) .

- Protect unique physiographic features.
- Protect areas where several natural subregions converge (i.e., the South Willow Creek area).

HYDROLOGY

General regional pattern objectives related to hydrologic processes are:

- Maintain watershed integrity by ensuring that all watersheds in the area meet the modified Interior Watershed Assessment Procedure (IWAP) standards. Currently, several watersheds, namely Stinson Creek, Pekisko Creek, Highwood River, Willow Creek, Lower Oldman, Beaver Creek, Crowsnest River, Dutch Creek, Racehorse Creek and the Upper Oldman, are assessed as being at potential risk and requiring further study.
- Undertake to remove or reclaim the amount of roading necessary to bring these basins within the acceptable limits of risk (after silvicultural obligations are complete).
- Ensure harvesting or construction methods on sites subject to erosion are appropriate. Minimize stream crossings.
- Ensure the amount of vegetation removal in the basin is at a level necessary to bring these basins within the acceptable limits of risk.
- Ensure that the amount and distribution of vegetation does not cause fluctuations in streamflows beyond the range of natural variability. Concentrate on the variation in the 10–year and 5–year events. Do not allow 10–year events to become 5–year or 5–year events to become 2–year events (as modelled in WRENNS).

VEGETATION

Vegetation diversity, patch size and age class distribution is to be maintained in the region. AVI limitations are recognized.

Diversity and Composition

The following are the objectives relating to maintenance of ecosite phase diversity in the region.

- Ensure all ecosite phases with representation of less than 100 ha are given priority attention for management. Do not allow their areal extent to drop below existing conditions. Manage other sites to ensure the areal extent is increased to 100 ha if possible.
- Allow no ecosite phases to disappear. In addition, maintain areal representation of ecosite phases within 20% of the area currently found in the region as indicated in Table A1. This species composition objective is based on maintaining close to the current species composition which developed under historical disturbance regimes.
- Maintain areal distribution of coniferous, deciduous, mixedwood, and grassland patch sizes within 20% of existing conditions as indicated in Table A2.

Table A1. Ecosite Phases of the Study Area

ECOSITE PHASE	AREA (HA)	% OF REGION
LICHEN LODGEPOLE PINE (811)	5,099.06	1.17%
BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	19,369.50	4.43%
SUBALPINE LARCH/HEATHER La–Fa (831)	3,348.31	0.77%
SPRUCE/HEATHER Se NORTH (841)	25,376.06	5.80%
FALSE AZALEA/THIMBLEBERRY Pl (851)	52,858.50	12.08%
FALSE AZALEA/GROUSEBERRY WHITEBARK PINE (852)	531.63	0.12%
FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	18,242.06	4.17%
FALSE AZALEA/THIMBLEBERRY Fa (854)	2,140.38	0.49%
HORSETAIL Se (881)	885.50	0.20%
TS–LIMBER PINE/JUNIPER Fd–Pf (2911)	637.13	0.15%
TS–BEARBERRY ASPEN (2922)	1,215.81	0.28%
TS–BEARBERRY Aw–Sw–Pl (2923)	2,581.75	0.59%
TS–BUFFALOBERRY/HAIRY WILD RYE Fd (2931)	591.38	0.14%
TS–BUFFALOBERRY/HAIRY WILD RYE Aw–Sw–Pl–Fd (2934)	1,610.69	0.37%
TS–CREEPING MAHONIA WHITE MEADOWSWEET Fd (2941)	2,170.31	0.50%
TS–CREEPING MAHONIA WHITE MEADOWSWEET Sw (2943)	681.44	0.16%
TS–THIMBLEBERRY PINE GRASS Aw (2952)	2,270.88	0.52%
TS–BALSAM POPLAR (2961)	1,057.00	0.24%
TS–HORSETAIL Sw–Pb (2971)	77.69	0.02%
LIMBER PINE/JUNIPER Fd–Pf (911)	4,253.25	0.97%
LIMBER PINE/JUNIPER Hc (912)	19.75	0.00%
BEARBERRY LODGEPOLE PINE (921)	8,913.19	2.04%
BEARBERRY ASPEN (922)	8,666.94	1.98%
BEARBERRY Aw–Sw–Pl (923)	3,804.75	0.87%
BUFFALOBERRY/HAIRY WILD RYE Fd (931)	4,080.13	0.93%
CREEPING MAHONIA WHITE MEADOWSWEET Fd (941)	23,087.44	5.28%
CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	20,197.06	4.62%
CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)	8,324.94	1.90%
THIMBLEBERRY PINE GRASS Aw (952)	20,060.44	4.59%
BALSAM POPLAR (961)	4,076.00	0.93%
HORSETAIL Sw–Pb (971)	924.06	0.21%
HORSETAIL Sw (972)	528.88	0.12%
TM–SUBALPINE LARCH/HEATHER La–Fa (2831)	7.81	0.00%
TM–FALSE AZALEA/THIMBLEBERRY Fa (2854)	266.50	0.06%
ROUGH FESCUE Parkland (1400)	15,459.50	3.53%
WILLOW GROVELAND (1402)	9,272.44	2.12%
WET SEDGE MEADOW (1403)	318.19	0.07%
DRY WILLOW Montane (1404)	5,248.56	1.20%
WET WILLOW (1406)	1,287.63	0.29%
DRY WILLOW Subalpine (1407)	704.56	0.16%
ROUGH FESCUE Subalpine (1408)	7,759.56	1.77%
STEEP HAIRY WILD RYE Subalpine (1409)	4,618.44	1.06%
WINDSWEPT RIDGES Subalpine (1410)	5,516.56	1.26%
WINDSWEPT RIDGES Alpine (1411)	3,880.38	0.89%
MOIST NORTH Alpine (1412)	118.88	0.03%
MOIST SOUTHWEST Alpine (1413)	66.63	0.02%
ROUGH FESCUE Foothills (1433)	47,175.00	10.78%
ROUGH FESCUE Montane (1934)	44,513.13	10.18%
BLUE BUNCH WHEATGRASS (1935)	660.88	0.15%
BEARBERRY GRASSLAND (1936)	16,818.06	3.84%
PINEGRASS HAIRY WILD RYE (1937)	844.31	0.19%
PK–LIMBER PINE/JUNIPER Fd–Pf (3911)	12.81	0.00%
PK–BEARBERRY LODGEPOLE PINE (3921)	149.19	0.03%
PK–BEARBERRY ASPEN (3922)	3,487.38	0.80%
PK–BEARBERRY Aw–Sw–Pl (3923)	481.81	0.11%
PK–BUFFALOBERRY/HAIRY WILD RYE–Fd (3931)	21.25	0.00%
PK–CREEPING MAHONIA WHITE MEADOWSWEET Fd (3941)	224.25	0.05%
PK–CREEPING MAHONIA WHITE MEADOWSWEET Pl (3942)	374.69	0.09%
PK–CREEPING MAHONIA WHITE MEADOWSWEET Sw (3943)	1,847.75	0.42%
PK–THIMBLEBERRY PINE GRASS Aw (3952)	10,165.13	2.32%
PK–BALSAM POPLAR (3961)	2,206.88	0.50%
PK–HORSETAIL Sw–Pb (3971)	395.31	0.09%
PK–HORSETAIL Sw (3972)	65.94	0.02%
FF–LIMBER PINE/JUNIPER Fd–Pf (4911)	15.50	0.00%
FF–BEARBERRY LODGEPOLE PINE (4921)	16.69	0.00%
FF–BEARBERRY ASPEN (4922)	223.38	0.05%
FF–BEARBERRY Aw–Sw–Pl (4923)	37.50	0.01%
FF–BUFFALOBERRY/HAIRY WILD RYE–Fd (4931)	8.75	0.00%
FF–CREEPING MAHONIA WHITE MEADOWSWEET Fd (4941)	248.25	0.06%
FF–CREEPING MAHONIA WHITE MEADOWSWEET Pl (4942)	61.38	0.01%
FF–CREEPING MAHONIA WHITE MEADOWSWEET Sw (4943)	135.19	0.03%
FF–THIMBLEBERRY PINE GRASS Aw (4952)	710.25	0.16%
FF–BALSAM POPLAR (4961)	593.94	0.14%
FF–HORSETAIL Sw–Pb (4971)	124.81	0.03%
FF–HORSETAIL Sw (4972)	2.31	0.00%

Table A2. Percent of Region in Broad Cover Type Patch Sizes

TYPE PATCH SIZE CLASS	CURRENT	PERCENT OF REGION COVER LOW (CURRENT–20%)	HIGH (CURRENT+20%)
Coniferous <2 ha	0.04%	0.03%	0.05%
Coniferous >=2 & <=10 ha	0.50%	0.40%	0.60%
Coniferous >10 & <=50 ha	1.42%	1.14%	1.70%
Coniferous >50 & <=250 ha	1.57%	1.25%	1.88%
Coniferous >250 & <=1,000 ha	1.80%	1.44%	2.16%
Coniferous >1,000 ha	34.81%	27.85%	41.77%
Deciduous <2 ha	0.05%	0.04%	0.06%
Deciduous >=2 & <=10 ha	0.81%	0.65%	0.98%
Deciduous >10 & <=50 ha	2.30%	1.84%	2.76%
Deciduous >50ha & <=250 ha	2.76%	2.21%	3.31%
Deciduous >250ha & <=1,000 ha	1.90%	1.52%	2.28%
Deciduous >1,000 ha	2.28%	1.82%	2.73%
Mixedwoods <2 ha	0.01%	0.01%	0.02%
Mixedwoods >=2 ha & <=10 ha	0.50%	0.40%	0.60%
Mixedwoods >10 ha & <=50 ha	1.89%	1.51%	2.27%
Mixedwoods >50 ha & <=250 ha	1.41%	1.13%	1.69%
Mixedwoods >250 ha & <=1,000 ha	0.13%	0.11%	0.16%
Mixedwoods >1,000 ha	0.26%	0.21%	0.31%
Grasslands <2 ha	0.19%	0.15%	0.22%
Grasslands >=2 ha & <=10 ha	1.26%	1.01%	1.51%
Grasslands >10 ha & <=50 ha	2.60%	2.08%	3.12%
Grasslands >50 ha & <=250 ha	2.86%	2.29%	3.44%
Grasslands >250 ha & <=1,000 ha	2.14%	1.71%	2.57%
Grasslands >1,000 ha	25.32%	20.26%	30.38%
Other <2 ha	0.06%	0.05%	0.07%
Other >=2 ha & <=10 ha	0.41%	0.33%	0.49%
Other >10 ha & <=50 ha	1.31%	1.05%	1.58%
Other >50 ha & <=250 ha	2.27%	1.82%	2.72%
Other >250 ha & <=1,000 ha	1.88%	1.50%	2.25%
Other >1,000 ha	5.25%	4.20%	6.30%
TOTAL	100.00%		

AGE CLASS

The following are the objectives relating to maintenance of age class distribution in the region.

- Allow no age classes to disappear
- Maintain broad age class distribution within 20% of the areal extent of the 1950 distribution (represented in Table A3)
- Maintain age class (by decade) patch size distribution according to Table A4
- With the exception of the classes over 5,000 ha, allow no size class to disappear

Table A3. Regional Age Class Targets (in hectares)

Age Class	1950 Area	Low	High
<20 years	3,575.0	2,860.0	4,290.0
21–40	14,485.0	11,588.0	17,382.0
41–80	137,749.0	110,199.2	165,298.8
81–120	82,592.0	66,073.6	99,110.4
121–160	12,877.0	10,301.6	15,452.4
161–200	7,727.0	6,181.6	9,272.4
>200 years	14,108.0	11,286.4	16,929.6

Table A4. Regional Age Class Patch Size Targets

Patch Size Class	% of forested area
<2 ha	0.25%
>2 and <=10 ha	5.26%
>10 and <=50 ha	21.76%
>50 and <=250 ha	27.55%
>250 and <=1,000 ha	21.03%
>1,000 ha and <=5,000 ha	18.28%
>5,000 ha and <=10,000 ha	0.00%
>10,000 ha	4.74%

FISHERIES

The broad resource objective is to increase the abundance, distribution and recreational opportunities of the fisheries resource by improvement of habitat quality. This will be accomplished through:

- Decreasing or limiting the number of active stream crossings
- Reducing the length of roads through reclamation and recontouring in critical sub basins; particularly the Crowsnest, Racehorse, Dutch and Upper Oldman, Lower Oldman and Livingstone basins
- Limiting changes in stream flow due to vegetation change beyond the natural range of variability (at all scales of analysis)
- An access management plan for the region needs to be developed

OTHER WILDLIFE RELATED OBJECTIVES

Wildlife related pattern objectives have been addressed in the sections on indispensable patterns. In addition, targets for habitat abundance for single species of special concern are provided.

Grizzly Bear

- Improvement of habitat effectiveness by controlling access and aggregating harvesting operations to reduce the extent of disturbance and necessary roading at any one time. Habitat effectiveness in the Porcupine Hills is NOT a priority due to wildlife ranchland conflict. Habitat effectiveness and bear movement shall be encouraged to the west of the Livingstone range.
- Maintenance (at a minimum) of large patches of existing effective habitat. Particularly, the large patches to the west of the Whaleback.
- Maintenance of all major potential corridors, particularly that on the west side of the Livingstone Range
- Identification of at least two passage points across Highway #3. Ensure connectivity is maintained and enhanced at these locations through measures such as land acquisition, consideration of structures, fencing and access management.
- Maintenance of east west connections to British Columbia, particularly Dead Man Pass, North Fork Pass, Tornado Pass and portions of the Crowsnest Pass itself
- Seasonal (winter only) harvest operations and access management in critical areas (e.g., areas of large contiguous patches of effective habitat and travel corridors linking these patches)

Elk

- Maintenance of existing amounts of food habitat in the montane areas
- Enhancement of food habitat in the subalpine areas. Enhancement of elk winter range in the Livingstone Valley in order to reduce potential predation on ranchlands to the east. Some south facing slopes may be subject to grassland conversion. Encroachment of forest cover into grassland which resulted from fire control and range enhancement through additional clearing will move the landscape closer to historical conditions.
- Protection of critical winter habitat. Enhancement in the area of the Crowsnest Mountain.
- Protection of major migration routes. Opening size is to be severely limited in those areas.
- Protection of calving areas. Opening size limitations and season operations will be required.

Moose

- Enhancement of food habitat in the subalpine areas. While deciduous and mixedwood is limited in the subalpine, some conversion should be considered as well as maintenance of shrub meadows.
- Protection of critical winter habitat. Reduce opening size in these areas to ensure protective cover adjacent to foraging areas (refer to moose habitat mapping).
- Protection of major migration routes. Opening size is to be severely limited in those areas.
- Protection of known calving areas. Opening size limitations and season operations may be required.

Mink

- Maintenance of riparian vegetation in order to provide hiding cover and travel corridors. Stream influence zone requirements as indicated previously are adequate for this purpose.
- Also required for fisheries in order to maintain food supply
- Manage human access roadways along streams

Marten

- Maintain existing levels of mature forest greater than 90 years old
- Provision of coarse woody debris

Barred Owl and Pileated Woodpecker

- Maintenance of older growth riparian balsam poplar forests for nesting habitat
- Maintenance of large patches of coniferous forest as foraging habitat
- Maintenance of significant amount of standing snags for both foraging and nesting habitat
- Maintenance of coarse woody debris within blocks

FOREST PROTECTION/FOREST HEALTH OBJECTIVES

Wildfire and disease risk management requires modification of the existing land patterns. The objective will be to convert or manipulate fuels to such an extent as to greatly reduce the possibility of a large conflagration. The land pattern objectives will be to:

- Provide landscape anchor areas from which to combat wildfires in order to contain fires within landscape compartments. The following are the compartments of priority:
  - Middle Ridges – Dutch Creek
  - Middle Ridges – Crowsnest Pass
  - Ironstone – Crowsnest River
  - Middle Ridges – Livingstone

Anchor points include :

- Fuel modification will occur on those sites with high potential head fire intensity. Prescribed fire, thinning, clearcutting and species conversion will be the major modification tools. The model of high potential head fire intensity, together with expert review, will be used to identify potential areas for fuel modification.
- The emphasis for treatment will be in the Middle Ridges landscape and other areas of potential high fire risk such as the Flathead and Ironstone Landscape Management Units to the south of the Crowsnest Pass.
- Areas subject to insects, disease and other pathogens will also be evaluated for pre–emptive harvest or sanitation cuts. In addition to field surveys, disease or insect models are to be used for identification of potential areas.
- The above objectives need to be integrated with other forest management objectives.

PROTECTED AREAS AND MONITORING SITES

Protected areas are required in order to provide ongoing and baseline measurements against which to measure the mid to long–term impacts of management on other similar lands. They are also needed in order to provide for the conservation of certain aspects of the region that are unique or representative of major ecological features and/or processes. As the area has among the highest biodiversity in the province as well as containing many unique and provincially significant resources, a careful protected area design is needed. This will be based upon:

- Existing legislated protected areas
- Areas of national and provincial environmental significance
- Degree of protection of areas of local significance

SOCIAL/ECONOMIC/CULTURAL OBJECTIVES

Visual Quality

- Limited cutting in those areas of highest visual value. Partial cutting and small irregular openings in the viewshed of major roadways and trails.
- Maintenance or expansion of mature forests as they are visually more highly preferred
- Eliminate rectilinear clearcutting in all areas
- Carry out remedial cutting in those areas where rectilinear, alternate clearcuts have already been implemented and which are, or are likely to become, highly visible or are adjacent to inherently highly valued landscapes
- Designate scenic byways on the Skyline Trail (and expand it to the north), Highway #22, the Forestry Trunk Road and the Allison Creek and Dutch Creek Roads
- Carry out detailed harvest design with the visual landscape in mind on all lands which are visible from roads and major trails
- Limit the perceived size of openings. Mimic the natural disturbance characteristics of pine beetles and irregular burns.

Access

Pattern objectives relating to access pertain to amount and type of roads, trails and transmission lines. Objectives in this area are:

- Reclaim all trails/cutlines that are not utilized for recreation or for silviculture or are important for fire control purposes
- Do not increase the total amount of improved roads in the area beyond improvements/additions to the:
  - Upper Oldman Road,
  - Allison Creek Road,
  - Dutch Creek Road, and
  - Skyline Trail (and its extension).
- Do not erect any additional overhead transmission lines
- An access management plan must be vigourously pursued
- All harvest roads shall be considered temporary, for industrial purposes only, and will be reclaimed immediately upon completion of harvesting and silvicultural operations

Table A5. Existing Roads, Rails, Trails and Transmission Lines in the Study Area (km)

Road Gravel One Lane	375.13
Road Gravel Two Lane	139.35
Road Paved Undivided Two Lanes	165.76
Road Unimproved	608.58
Trail Cutline	6072.64
Trail Truck	197.74
Rail Line Single Track	52.34
Rail Line Spur	4.21
Major Pipeline	368.75
Transmission Line Major	163.20

Archaeological/Cultural Resource Protection

Cultural resource protection is needed in order to conserve these resources for future generations. High priority protection will be given to stands over 200 years old at high elevations due to the scientific importance of these stands to climate research. The following are the related pattern objectives:

- All identified cultural and archaeological resources will be buffered by at least 100 m on all sides.
- All old growth stands (over 200 years) at high elevations (over 2,000 m) will be withdrawn from harvest.

RESOURCE UTILIZATION, MANAGEMENT AND DISTRIBUTION

The study area is currently utilized by many sectors of the economy. Pattern objectives relating to the various sectors follow.

Oil and Gas

Energy related operations are likely to remain a landscape stressor. Exact locations of likely activities have not been finalized nor are they likely to be within the life of the project. Therefore, the following assumptions have been made:

- Oil and gas activity will not be aggregated and will continue throughout the entire study area, but with an emphasis on the Whaleback, Saddle Mountain, Porcupine Hills, Upper Livingstone and Middle Ridge landscape management units
- Roads associated with the developments will be minimized both in length and width
- Access to those roads will be considered restricted
- Multi well directional drilling techniques will be utilized, as will portable helicopter borne exploration techniques
- Cut lines and access used by the energy business will be reduced in overall footprint. However, the cumulative impact of this sector is additive.

Mining

The possibility of coal mining in the area does exist and several leases are still current. However, due to the importance of other uses in the area, it is not anticipated that surface mining will be undertaken in the foreseeable future. Therefore, pattern objectives are:

- Existing surface mines in the area of the Crowsnest pass on Grassy Mountain should be recontoured and revegetated with native vegetation. For the most part, these will not be reforested.

Recreation and Tourism

Recreational use of the area is increasing and the following are the land pattern objectives.

- Formalize the use of the random camping areas (on appropriate sites only) and restrict vehicular camping to those areas
- Continue with all designated campsites and trails
- Designate all trails currently in use by outfitters, snowmobilers, skiers and hikers
- Place staging areas as indicated in the Recreation Scenario at the forestry reserve boundary at the Livingstone Gap and Allison Creek
- Utilize visual resource management planning throughout the area. Rectilinear cutblocks shall be avoided.
- Scenic quality of the area will be emphasized, protected and enhanced
- The following Scenic Byways will be designated and, in some cases, upgraded:
  - The Forestry Trunk Road
  - The Skyline Trail in the Porcupine Hills. Upgrading/extension of the Skyline Trail to the north will be considered.
  - The Dutch Creek/Allison Creek Road will be considered
- Access will be managed to maximize recreational opportunity
- Some roads may be upgraded
- New roads may be considered
- Some roads may be reclaimed to trail status
- Backcountry opportunities will be provided
- Multi–day backcountry opportunities
- The road will be closed at the Old Man Falls
- Access will be provided for many day hiking trips
- An extensive trail system of multiple types (hiking, equestrian, bicycle, ski) will be constructed/designated and maintained
- Motorized vehicular use of the backcountry will be provided in some areas
- A motorized vehicle area similar to the Mclean Creek Area will be designated
- An extensive trail system within this zone will be designated and maintained
- Random vehicular accessed camping areas will be designated
- Telemark ski areas will be considered in association with the harvesting operations
- Hunting and fishing will be enhanced
- Wildlife habitat for huntable or viewable species will be enhanced
- Fisheries habitat will be enhanced including the development of "put and take" areas

Arable Agriculture and Grazing

Agriculture and grazing are expected to continue throughout much of the area. Many of the pattern objectives relate to areas under private ownership. Land owners should be encouraged to adopt the objectives. The pattern objectives of this sector are seen as:

- Aggregate perennial and annual crops. Do not expand the area of such crops more than 10% in the 20–year life of the plan.
- Encourage land owners to maintain existing native vegetation
- Ensure that islands and corridors of native vegetation are retained or installed within the larger patches of agronomic species
- Allow no rangeland conversion to agronomic species on Crown lands
- Manage aspen and willow to reduce encroachment into grasslands on Crown lands
- Encourage the two above objectives on private lands

Forestry

Forestry operations will continue into the foreseeable future. Regardless of the future management emphasis, forestry for fuel management and maintenance of the disturbance regime will be necessary. The following are the patterns associated with timber extraction.

- Timber harvesting will be aggregated in order to reduce road costs, minimize access and more fully replicate the pattern of fire on the landscape
- Stands infested with mountain pine beetle will be sanitized
- Alternative silviculture systems will be established in those areas of highest visibility and where silvicultural considerations allow
- Utilize visual resource management planning throughout the area. Rectilinear cutblocks shall be avoided.
- Additional cutting may be done on a one–time basis to satisfy fuel modification requirements
- There will be some effect on the AAC for the area as some immature stands may be required to be harvested and some stand break up may occur as a result of longer rotations and longer leave times until the residual is cut
- Regeneration should be directed at maintaining species composition objectives listed previously. Currently, the emphasis is on pine regeneration. Additional efforts should be made to regenerate Spruce and Douglas Fir.

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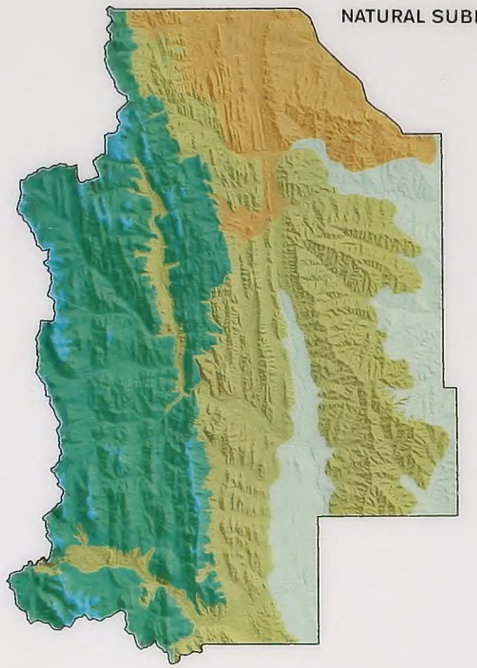
NATURAL SUBREGIONS



Alpine
Subalpine
Montane
Foothills Parkland
Foothills Fescue

Kilometers
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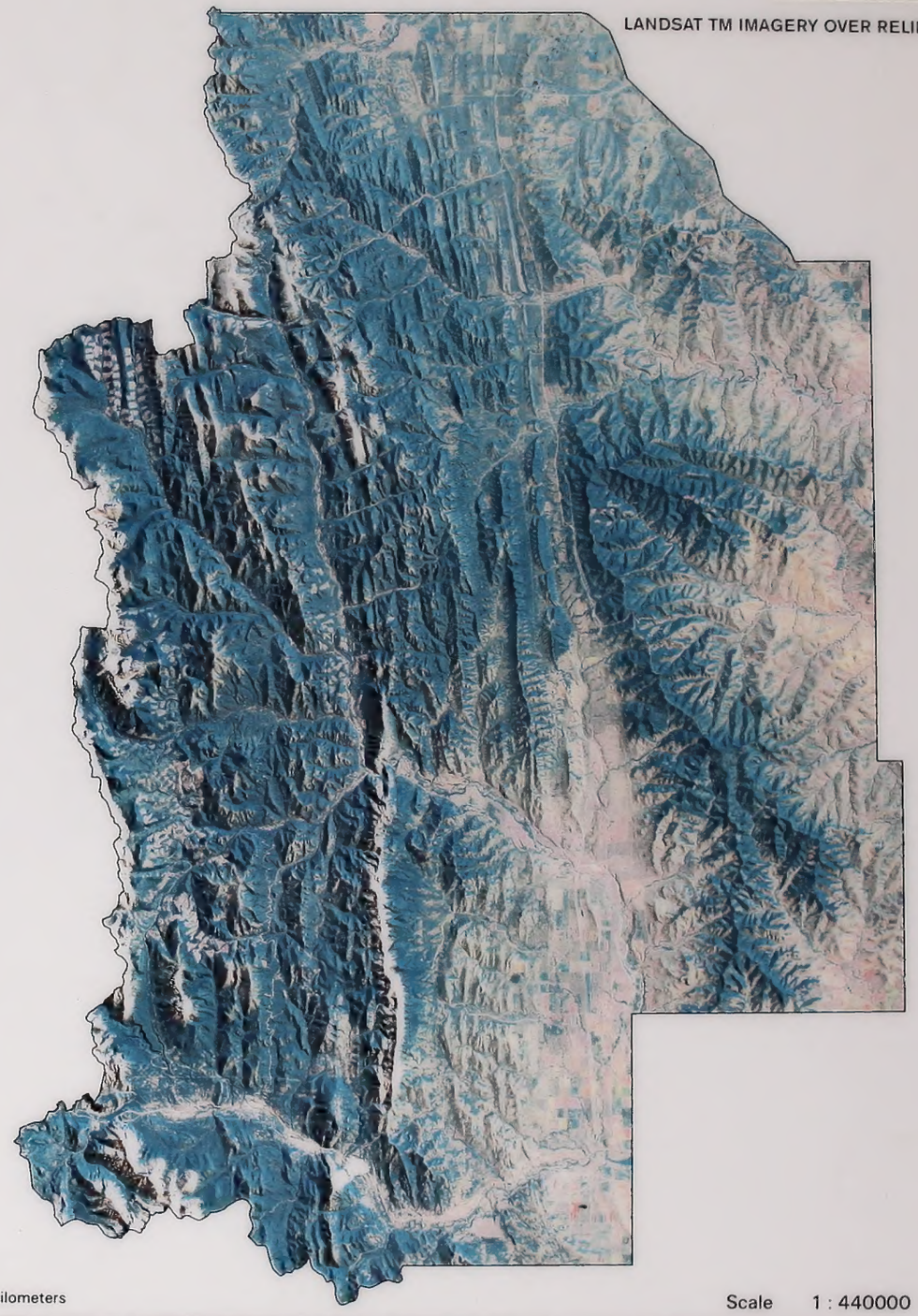
Scale 1 : 925000

LANDSAT TM IMAGERY OVER RELIEF



Kilometers
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The Southern Rockies Landscape Planning Pilot Study